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The Fixation of atmospheric Nitrogen by dead leaves.

Following the important work of M. Henry, whose successful research will be doubly grateful to many Indian foresters for reasons of personal regard, comes a note by M. L. Détrie on the same problem, *viz.*, the reasons *for the continual* improvement of forest soils, notwithstanding the fact that more nitrogen is removed from them than is known to be *acquired by them*. The *disastrous results of the removal* of dead leaves, causing sometimes a loss of as much as 50 per cent., of the normal annual production, are well known to foresters, but have not yet been borne in upon the unwilling minds which oppose forest conservancy. This loss, at any rate the most *serious* loss, is nitrogen. As regards sufficiency of other food supply, it may be granted that all soils, all waters, all atmospheres are rich enough to keep forests growing for ever. The mineral *constituents*, *salts*, &c., necessary to the continued formation of cellulose, starch and other reserve materials, are always to be found in sufficient quantities, resulting from decompositions or recombinations *in the soil or atmosphere.* But nitrogen, the indispensable, the arbiter of the rate of growth, even of life and death, is an extremely variable quantity. The German experimental stations proved the *amount of lost growth* caused by the removal of dead leaves. M. Grandeau showed that the covering of dead leaves has a great influence on the *amount of nitrogen carried in the soil.* Then came the knowledge of the important part played by micro-organisms, moulds, ferments, microbes &c., in the decomposition of vegetable matter, and it was seen that the layer of dead leaves is not only a layer of partly digestible food material, but is especially a layer of *microbes*, ferments, &c., a kitchen in fact, where the indigestible materials are rendered easily assimilable. It follows that the mere raking about of the layer, not to

speak of its removal, interrupts the microbe-cooks and the scullion ferments at their work, and may even kill and bury them under the ruins of their kitchen.

The removal of leaves is thus a wasteful process, since the benefit accruing to the robber is far less than the damage caused to the forest. About this period, namely June 1893, M. Détrie just glimpsed the conclusions which M. Henry has worked out, since he wrote that "the removal, or mere moving, 'of the layer of dead leaves, not only interferes with the for- 'mation of vegetable mould, but actually *diminishes the fixa- 'tion of nitrogen in the soil by stopping the development of mi- 'cro-organisms*." It remained for M. Henry to decipher the details. Even yet, there are illegible lines at the bottom of the page, and M. Détrie asks for an interpretation. Granted that the increment is affected by the chemico-plysical action of the layer of dead leaves, how can this be reconciled with the admittedly greater increment in the standards after the cutting of the coppice, that is to say, at a period when the layer has been practically destroyed? M. Bartet's experiments showed that in high forest of 3 ages, up to a height of 9 m. 30 cm, the curve of diametral increment is inflected from the 1st to the 3rd decennial period, that is, inversely to the thickness of the layer of dead leaves. The cause of this greater increment is not explained, although theories more or less at variance with existing knowledge have been propounded. The problem has puzzled M. Détrie for the last 10 years, perhaps some Indian forester can throw light upon it.

Imports of Quebracho wood into Germany.

The following translation of an article in the *Révue des Eaux et Forêts* by M. H. de Clercq, Vice-Consul of France, should be of interest to Indian Forest Officers as it shows that it is desirable that India should join in the competition for tannin stuffs and should as far as possible follow the example of America and use tannin material of local production.

The imports of the wood and extract of quebracho into Germany, which had attained such large proportions during these last years, are at the present moment showing a marked retrograde movement. After having risen to 81,395 tons in 1895, they did not reach higher than 67,395 tons in 1896, being a falling off of 20,210 tons. And if, in the meantime, nothing occurs to modify existing economic conditions, there is a strong probability of a further decrease. The entries during the first quarter of 1897 do not exceed 6,645 tons and prove a diminution of 60 per cent., on the figures for the corresponding period of 1896.

If the Reichstag must, to a certain extent, be held responsible for this result, seeing that it has imposed on these products duties which German tanners maintain are excessive and injurious to their industry in the face of competition from abroad, there are nevertheless other causes which have contributed to the same result in a not less effective manner.

If those interested in the matter are to be believed, the American Leather Syndicate is one of these causes. By favouring the development of the tanning business in America, it has by that fact itself brought forward into the market a purchaser who has swept up all existing and available stocks, thereby creating wide fluctuations of prices, so that it is believed that the trade in the wood and extract has been hit hard by him, if not definitively killed.

Without denying the share of the syndicate in reducing the imports of quebracho into Germany, it is quite as probable that the principal cause of the diminished supply of the wood entering the markets is the extensive use of it made by the Government of the Argentine Republic. As we already know, in that country the wood is employed for railway sleepers on account of its great strength, density and durability, and the results hitherto obtained have been so satisfactory and encouraging, that such employment of the wood is daily on the increase and there is even an idea of protecting the home supply by means of an export duty. If this idea eventually becomes a fact, the importation of quebracho into Germany will be rendered almost impossible, and the scarcity of the product, resulting in a further enhancement of prices, will not fail to increase the pressure already felt by the tanners of that country.

This pressure will be felt all the more acutely that the owners of woods and forests, having had to give up barking their oaks owing to the great fall in the price of oak bark, now almost completely forsaken for quebracho, will not fail to do their best in order to recoup themselves for past losses. And they will have every chance of succeeding ; for in the absence of the American wood and of other substances which, like chestnut wood, divi-divi, hemlock spruce, sumach and so on, which have taken the place of oak bark, but the tanning value of which is very variable and which are held in different degrees of estimation by different individuals in the leather industry, a return to oak bark will be inevitable. Now foresters believe that Germany is no longer able to meet the demands of its tanners for this article. The partiality of the tanners for quebracho, it is affirmed, and their agitation for a reduction of the import duty on it, have led forest proprietors, both large and small, to substitute in all recent plantations pine and silver fir for oak.

If such is really the case, and after discounting for exaggeration I must admit it, the German tanners will (unless their Government comes to their rescue) as a result of a situation which they themselves have assisted to create, find themselves face to face with difficulties particularly hard to solve, on the solution of which, however, will hang the fate of their industry.

Cacao and India Rubber in Mexico.

(Extract from Foreign Office Report No. 385 Miscellaneous series of 1895, by Mr. H. N. Dering.

The Cacao of Mexico.—Full Description of its Cultivation.

The tree that produces the "food of the gods" (chocolate), "*Theobroma Cacao*" of Linnæus, "cacari," or "cacava quahuitl" of the ancient Mexicans, and "cacao" of the Spaniards, is a native of Mexico.

Long before the Conquest, the Aztecs and other ancient Mexican tribes used the fruit as one of their alimentary beverages. They prepared a drink called chocolatl by mixing the seeds, after having crushed them on the metatl, together with fine corn meal, vanilla ("tlilxochitl") and a species of spice called "mecaxocoitl," and those that drank it were a picture of health, preserving handsome and vivid features even to old age. All nations subjugated under the Aztec eagle had to bring, among other valuables, a certain number of bags of cacao to the palace in the great Tenochtitla as an annual tribute to the Emperor. It was so highly prized amongst the ancient natives, that in trade it was utilised as currency among the lower classes.

The varieties cultivated were namely :—the quauhcahuatl," "mecacahuatl," "zochicucahuatl," and "tlacacahuatl." The bean of the last one was very small, analogous to the kind found at present at Soconusco, Chiapas. The fruit produced in Zoconochco, in the provinces of Tabasco and Chiapas was considered as the best.

The followers of Hernan Cortez endeavoured in vain to maintain the plantations then existing, but it is a well-known fact that in the conquest of this country by the Spaniards, agriculture and the industries then known retrograded so much that the cultivation of the cacao, as well as that of the cotton plant, suffered to such an extent as almost to reduce both to a wild state. The conquered Mexicans were compelled to work in the mines and serve in slavery, and were thereby obliged to neglect their plantations. And as the conquerers were not versed in the culture, the industry was

nearly abandoned and did not take a new life until some Spaniards started one or to two large plantations in Choutalpa, Tabasco, a few years before Mexico threw off the Spanish yoke. Other plantations were established in different sections of Tabasco and Chiapas.

Chocolate, the product of the fruit, was first introduced into Europe (Spain) by the Spaniards from Mexico. Portugal followed in the use of it; France and England did not appreciate its full qualities until the latter part of the seventeenth century. After the year 1878 it came into vogue in all the cities in Europe. Its alimentary virtues became more generally known, and Doret, a Frenchman, invented a hydraulic machine to manufacture it on a large scale. Since then all civilised nations have consumed this rich American product of Mexican origin, which up to date is not produced in sufficient quantities to meet the word's consumption.

This tree is found growing wild and in cultivation in the States of Colima, Michoacan, Guerrero, Oaxaca (districts of Jamiltepec and Tuxtepec). Chipas (districts of Soconusco, Mezcalapa, Pichucalco, Simojovel, and Palenque), Tabasco, and central and southern Vera Cruz, where the elevation is from 100 to 1,200 feet above sea-level, but Chiapas and Tabasco are noted as being its home, the climate and soil there being more particularly adapted to its culture and development than any other portion of the globe.

The production of cacao in the year 1893 was 2,147,730 kilos, valued at 837,197 dol. In 1870 the States of Tabasco, Colima, Chiapas, Guerrero, Michacoan, Oaxaca, and Vera Cruz had 569,795 trees in cultivation, producing an annual crop of 31,285 quintals, worth to the planters 782,125 dol.

Cacao is an evergreen tree of medium size, which if grown in a good soil and left to itself will reach a height of 20 to 30 feet, and spead out to an extent of 10 feet or more on each side. At the height of a few feet from the ground it sends out three to six *lateral branches* ("horquetas") without any sign of a leading stem, and it is only when the branches are matured that a leader or leaders ("rama chupona") spring out from the side, and not from the centre of these branches. The leaves are smooth, alternate, lanceolate, pendent, of a deep green colour, 9 to 10 inches long by 3 inches across. The flowers small, of a pale yellow or very light red colour, and they come off in a bunch from the stem, branches, and the place where a leaf formerly existed. It is rarely that more than one of them develops into fruit, and thus many more flowers are borne on the trees than fruit pods. The cucumber-shaped pods are 5 to 9 inches long, and nearly 4 inches in diameter at their widest part, with a thick, almost woody rind. They are

pinched in at the top and pointed at the end, the point being curved to one side. The skin is first light green, then of a yellowish red colour, with ten furrows and tuberculated ridges. These indicate a five-celled fruit, which contains on an average 38 seeds, embedded in its sweetish pulp.

The species most cultivated in Mexico are: Cacao or *Theobroma ovalifolia T. bicolor* and *T. angustifolia* There are other kinds known, generally found growing wild, which come under the head of the Guazumæ or guacima, *Guazuma polybotrya* ' being the principal species.

Practice and study have shown us that the chocolate tree will thrive well in virgin lands recently cleared, but rich in organic matter and minerals, and as it has a long tap root, the surface soil needs to be deep and thick with humus. The best soil, however, is that occurring in valleys and undulating lands, along the banks of rivers or streams made by years of alluvial deposits, or by the decomposition of volcanic rocks. A proof of this is shown in the department of Soconusco, Chiapas. It will also grow well in loams and the richer marls, but it will not thrive in stiff heavy clay.

A warm moist climate, having a mean temperature between 76° and 77° Fahr., is necessary for the cultivation of cacao if large crops are expected, but, when the soil is suitable, the tree will grow and give fair returns in a moderately dry or well drained location. The ordinary cacao plant will not do well in the mountains above 600 metres (1,968 feet), and even at that height it becomes stunted, and is fruitful only for a few years. The best elevation is from 300 to 500 feet, and in sheltered situations near the seashore good crops are to be obtained, but the tree will not thrive if exposed to the direct influence of the sea-breeze. Cacao will not bear much exposure, hence sheltered lands and valleys should be selected, and on the Gulf side of Chiapas, Tabasco and Vera Cruz, northern and eastern aspects should be avoided. Still, locations in Colima, Michoacan, Guerrero, and Oaxaca, on the Pacific side having a south and south-western exposure must not be preferred for the formation of successful plantations.

Cacao plants are obtained from the seed which germinates readily and quickly. The best-looking pods from the April or May crop which are not over-ripe should be picked for the purpose. Those known as hechas are generally preferred by the planters. These are distinguished from the viches by their light colour, solid appearance, the seeds not rattling inside. After selecting the largest seeds from healthy pods, the former are soaked in lukewarm water for 12 or 18 hours, avoiding those assuming a reddish tint, and likewise those floating on the water. The rest are left to dry.

A virgin spot close to a spring or stream whose soil is not porous, in the immediate vicinity of the plot to be planted, should be selected for the nursery. For the convenience of handing, more than one nursery should be formed along the plot. 300 feet distant, if a large sized plantation is to be established. The spot is prepared by hoeing the soil, extracting the weeds and roots, and pulverising the earth with a rake; then beds are made 5 feet wide by any length, separating each one by a walk 3 feet wide. Small furrows are made about an inch in depth and about 12 inches apart, and seeds are sown in them 8 inches one from the other. That part of the seed attached to the stringy centre of the pods is the one to be placed downwards in sowing. The seed is covered with vegetable mould or loose loam mixed with horse manure, and over that banana leaves. The bed is sprinkled every day for 12 or 15 days, when seedlings appear. Then the banana leaves are removed, and sheds, made of palm leaves and sticks, so fixed that they can be raised as the seedling grows, should be placed over the nursery as shade and shelter; no weeds or grass are allowed on the beds.

The sprinkling should be continued when necessary, or on rainless days, and the palm leaves are gradually taken off, but not altogether until the plants are ready to transplant. The operation of forming the nursery is done in some places in the month of April and May, and in other localities as late as September.

Either in the month of February or March the planter's attention must be directed to the preparation of the land; in some places, where the rains cease early in the season, that is done in December or January. The forests having been cut down (tumba) the branches must be lopped and strewn (rozada) evenly over the ground before they are burnt (quemada). But when the forest is cleared, shade belts should be left, or afterwards planted in exposed places so as to shelter the cacao trees from the wind.

Of course the felled forest trees must be allowed to remain for a time exposed to the sun, otherwise the smaller branches will not catch fire properly. Where possible it is better not to burn the bush, but to pack it in lines between the young plants or madres, in order that, by its rotting, it may add to the richness of the soil, otherwise the nitrogenous compounds so beneficial to plant life are sent off into the atmosphere by the burning.

Immediately after the burning, which should take place in April, or a month after the land is cleared, corn and beans are sown on the plot. If the land has no natural trees suitable for shade, mother cacao (madres) are looked for such as mataraton, pito, cocoite, chipilcocoite, and chontal. The last-named, a broad leaved tree, is not good for anything but to give shade and

shelter. Cocoite and chipilcocoite, small leaved trees, are hard wood and are used by preference for posts for houses. These trees are obtained from forests in the shape of cuttings or young plants, and planted in the beginning of the rainy season and at a distance of from 15 to 18 feet apart on rich, flat land, but on poorer *soil and on hill sides, from 12 to 16 feet will* be the proper distance. Rubber can also be planted as shade, but it requires more scientific work and care. In July and August the corn and beans are harvested, and the plot thoroughly cleaned ; the banana suckers can then be planted between every four madres, providing rubber has not been thought of and no preparations made to raise it. In the spring of the following year another crop of corn can be sown between the madres leaving a hill close to the place destined for the cacao seedling which will serve as chichihuas, temporary shade, to the young plant when transplanted. In Chiapas and Tabasco trees *called* challa and madre serrana are utilised for this purpose. A year after sowing, seedings are 50 centims. (20 inches) high and ready to be transplanted.

In the beginning of the rains, on a cloudy day, the operation of transplanting is proceeded with. A peon with a machete cuts a square line around the seedling and with a spade (coa) lifts up earth and seedling; this is done in 15 to 20 minutes. Then another peon wraps up the whole mass with a large leaf grown *on a plant* called hoja blanca, found in those sections. In the meantime the holes are being made, they are dug 8½ feet away from the madres if these are set 17 feet apart, so as to form a square with a mother cacao in the middle. The holes should be 2 feet square and 2 feet deep, that is 8 cubic feet of earth must be taken up, this can be done by a practical man inside of 5 minutes, in soft soil. The earth around the seedling after transplanting must be well pressed with the foot, but at the same time, before finishing that operation, dried leaves are mixed with the soil to be placed on top.

Of course, land under cacao cultivation, as under all proper and successful cultivation, should be keep clear of weeds. In the first place the plot should be drained off to ensure quick crops ; and then proper tillage will improve the soil and do good to the trees. To accomplish this, 4 weedings (ladeas) are necessary in the first 3 years, 3 in the second 3 years, and 2 in the following years. On steep hill sides cutlassing will be sufficient, and on level places hoeing will be required. When the trees are grown so that their branches shade the land, the weeds will not grow very fast, and as a rule they are so loosely rooted that they may be *easily pulled up. The cultivation* and harvesting of the side crops must be attended to in due time. The cacao planter should give careful attention to the pruning of the trees and trimming of the madres if he wishes to get a large yield. As the pods are borne on the larger branches, the principle is to

develop such branches by judicious pruning and to see that they are not covered up by a mass of foliage and small twigs. A typical cacao tree should have one stem, giving off at a few feet from the ground three or five branches which spread in an open manner and are free from leaves except at the top ; thus the leaves shade the open inner portion without interfering with a free circulation of the air. If the young plants throw out more than one main stem, the surplus ones (mamones or chuponas) must be prumed off when the moon is on the wane, and after the lateral branches are formed no upward prolongation of the stem must be allowed to grow. If the tree be left alone these upward growing branches will come off from the stem just below the laterals, in the form suckers, and to leave them on is to cause the strength to be taken from these fruitful laterals, as well as to allow the trees to run up, perhaps for 30 feet or more, thereby causing much trouble in picking the pods. When the suckers are pruned off, fresh ones will grow in a short time, generally in a month, so that the trees will require frequent attention until they are mature, when the tendency to throw out suckers will be stopped. In gathering the pods, the suckers may be taken off at the same time, but the trees should not be pruned in the flowering season.

Unless in the case of sickly plants on poor soil the trees will not require manuring until the crops are taken off, when, as may be imagined, it will be necessary to restore to the soil, in a cheap way, what has been removed in the valuable produce. A good deal will depend on the nature of the soil and the yield of the trees. Should crops which were abundant, be found to be falling off, it is an indication that manure is necessary. A compost of yard manure and bone dust in the proportion of 5,000 cart loads of yard manure and 500 lbs. of bone dust per hectare of land applied every 3 years is all that is required. The successful harvesting of cacao requires great care and watchfulness, as it is a fruit that has many enemies, the principal ones being parrots, squirrels, tusas (a species of gopher), tepeiscuintle another animal of the rodent class, and ants especially those known under the name of arrieras. But damage by these can be obviated by proper cultivation and care.

Returns from a cacao plantation (motelar) can not be expected until after 5 years from transplanting. At 2 years old the tree, in rich soil, stands 5 or 6 feet high ; when 7 or 8 feet high it begins to bear (jugar), but it is not in full bearing (cuaja) until it is between 10 and 12 feet high. The first flowers under favourable conditions will come out at the third year, but, as the tree is not matured then, they should by no means be allowed to produce pods, otherwise the plant will be so weakened by the fruiting that its growth will be greatly checked. The first flowers, therefore, should all be rubbed off.

After the leaves of the flower fall, a bud appears like the common Mexican chile pepper and takes 3 or 4 months to mature. Peons or mozos must be employed daily until the crop is harvested, as birds and squirrels are apt to eat the bud and afterwards the seed. The cacao tree flowers all the year round, and the pickings of the fruit are divided into four harvests or seasons. The first, which covers the first 3 months of the year, is known as inveranada; the second, lasting through April, May, and June, is the cosecha or harvest proper, and is the most abundant of the four; the product of the third, extending over July, August, and September, is known as cacao loco; and that of the three last months of the year as alegron.

The average yield of dry cacao from each tree of course varies very much. The limits may be said to be from 1½ to 8 lbs. per tree. Some trees in the plantation of "La Carolina," district of Macuspana, Tabasco, produce 220 pods, and plantations in Alvarez, Colima, and in Apatzingan, Michovean, yield on an average 5 lbs. to the tree. Generally, one can reckon on 50 pods (mazorcas) per tree a year, which produce from 30 to 40 kernels (almendras), and 250 dried kernels will weigh 1 lb. The trees of cacao blanco or verdoso and cacao morado yield the most, hence the Tabasco and Chiapas planters prefer them above the other kinds. Chocolate trees last from 30 to 40 years and produce fruit for 20 to 25 years by proper cultivation.

In picking (el corte) the pods, care should be taken that they are fully ripe. A little observation and experience is all that is necessary to tell at once by the look whether the pod be ripe or not.

If it be within reach, it may be tapped with the knuckles or with the handle of a knife, and if it sound hollow it is ready for picking. The fruit must be cut from the tree with a machete, cacao knife or cacao hook, and on no account ought it to be twisted or torn off the tree, nor the fruit to be allowed to drop on the ground.

The cut should be clean and as close to the pod as possible, for, if a tree be examined, it will be found that at the base of the stalk of the pod there is a little swelling called the eye, and it is from this part that the flowers for the next crop will come out. If, therefore, the eye be torn away no more pods can come out from that part of the stem.

The pods, having been gathered, are placed in heaps under the trees; then they are taken to a place called quebradero, where they may be broken at once or left for a day. The kernels or nibs are then taken out of the pods which are either opened with a machete, or a knife made from a wood called jahuacte. The seeds may be drawn with the fingers, or by

means of a wooden spoon, and at the same time the white fibrous tissue is taken away. This stringy stuff and the broken pods should be put in heaps to rot for manure, or be spread over the roots of the trees, or better still be buried between the trees, and in this way something will be given back to the soil.

As the seeds are extracted from the pods, the former are thrown into wooden troughs called tollas, half-filled with water, to wash them; the beans are now carried away to the cacao house for the purpose of being made to undergo the sweating or fermentation process. This is a very important matter for the planter, inasmuch on its proper performance depends, to a great extent, the value of his produce. In some places the cacao beans are simply dried as soon as they are taken out of the pods, and the cacao thus prepared is sold or shipped to the markets. But it is very inferior stuff with a bitter unpleasant taste, and it fetches a low price. Sweating is simple and inexpensive. It may be done in boxes or barrels or in an air-tight room. The cacao is put into a receptacle, it is covered with plantain (platano) leaves, boards are put on the top, and it is left to ferment for about 3 days, when it is removed to another receptacle, closed up again, and allowed to sweat for 3 days longer. The object of opening the cacao is to cause the fermentation to be equal: for, in changing it, that which is on top at first becomes the bottom layer in the second receptacle, and thus uniformity is secured. When the cacao is sweated in heaps in a closed house, the heap must be turned over or stirred up on the third day, and in this way the outside beans will get their full turn of the fermentation process. Some fine kinds of cacao do not require to sweat so long, but experience alone can determine this point. In the fermentation, the first stages of the germination of the seed go on. The moisture, warmth, and a certain amount of air cause the seeds to swell, carbonic acid is given off, and the food stored up in the seed for the use of th embryo is converted into soluble matter, and this accounts for the modification of the bitter taste of the raw bean brought about by the sweating process. In some places the beans are sweated without washing them, claiming that thus the aromatic principles of the cacao are not altered. The beans having been properly sweated they are to be dried ready for shipment. The drying may be done in wooden trays or on paved or cemented platforms or yards. Also a fixture can be made where the trays are placed stationary and a roof on rollers placed over them. When the sun is out the roof is rolled back and the cacao beans exposed; during rain and at nights the roof is rolled over the trays and in this way time and labour in carrying out the trays and taking them in again are saved. When they are dried in yards, the sweated beans are spread out thinly, well

rubbed and exposed to the sun in the morning, and at mid-day they are put back in the sweating boxes or houses to undergo another partial fermentation, for if they be dried straight off they will deteriorate in value. A peon must turn them over once in a while during the day so as to expose the whole seed, otherwise one side only will become red and the other black. The second day they are kept longer in the sun, and the third day they are kept out as long as the sun lasts. They are put out on succeeding days until they are thoroughly dry, which is told by their producing a crackling sensation when pressed between the thumb and forefinger, or when the parchment (outer skin) breaks off easily. To brighten the colour to a deeper red the seed is washed in 33 per cent. solution of lemon or sour orange juice. Sometimes the cacao is clayed, and this can be done by sprinkling the beans with red clay that has been dried and pulverised, immediately after they have been removed from the sweating boxes. On the second day the same process is gone through if the clay has not tinged all the beans. Then the beans are rubbed between the hands for an our or two in order to clear away the surplus mucilaginous matter. The drying is afterwards finished as usual. Clayed cacao has a reddish appearance and the colour is uniform, and it usually fetches big prices in the markets.

The market classification known as Tabasco and Chiapas consists of cacao colorado as first class, cacao palenque as second class, and cacao pacha as third class. The uses of cacao are many; the broken or empty pods besides being a good fertiliser are used by the peons, roasted, in lieu of chocolate on account of their low price. A mixture, called pozol or chorote, made of ground pop-corn, piloncillo (brown sugar), and cacao, is used in water by the weary traveller or by the fatigued peon in the field as a nutritious and refreshing drink. A preparation called broma or cocoa is manufactured and very much appreciated by the cold-blooded Anglo-Saxon. The cacao-nibs ground in paste sweetened and flavoured with vanilla and cinnamon, yield chocolate, so much relished by the Latin races. Lastly, the oil of the seed yields a non-rancid fat, cacao butter, used in pharmaceutical preparations.

As to cost and expense, generally cacao planters in Chiapas and Tabasco make contracts paying 90 to 100 dol. per 1,000 trees, according to the location, facilities of transportation, etc, to be delivered in a state of production in 4 years, the plantation to be in good condition and with proper shade. The contractor keeps the products and first crop of the plantation. If the planter has his own labourers, he pays them from 5 to 8 dol. per month and rations, then the cost will be from 70 to 80 dol. per 1,000 trees. Where the labour is not done by

contract but by jornales, or tasks, the cost for 6 years per hectare (2·471 acres) is as follows :—

	At 50 c. per Task. Dol.	c.
10 tasks for the stubbing	5	0
12 ,, for felling trees	6	0
4 ,, for collecting brush	2	0
6 ,, for collecting trees	3	0
3 ,, for burning	1	50
2 ,, to cut 375 madre cuttings	1	0
2 ,, to carry them to the plot	1	0
4 ,, for planting same	2	0
100 cacao pods for nursery	2	0
10 tasks to establish nursery, with shade	6	0
6 ,, for weeding the nursery	3	0
20 ,, for hoeing or ploughing plot	10	0
5 ,, for digging the cacao seedlings	2	50
15 ,, for transplanting and transporting ..	7	50
140 ,, six years weeding	70	0
136 ,, for replacing and pruning trees	68	0
Cost of the land	1	0
Consequently there is a cost of ...	191	50

for 750 trees. The expense of collecting, drying, and sacking the seed is from 3 to 5 dol. per carga of 60 lbs.

Thus 750 trees will produce the planter 75 cargas (4,500 lbs.) the price of which is from 20 dol. to 22 dol. per carga at the plantation. Deducting the cost of curing, he will have a net annual profit of more than 1,225 dol., besides the product obtained from corn, bananas, and vanilla raised as side crops, and bees.

The Mexican Rubber.

The rubber tree (*Castilloa elastica* of Cervantes, olquaquitl of the Aztecs, hule of the Spaniards) is indigenous in Mexico, and is found growing wild along both coasts, below 22 degrees North latitude, from sea-level to altitudes running from 1,200 to 1,500 feet, and principally by the river meadows. The *region most favourable for the growth of this important yet* rarely cultivated tree are: the plains of Pochutla, Oaxaca, between the Pacific Ocean and the base of the Sierra Madre Cordillera, and also along the banks of the Copalita River ; in Soconusco, Chiapas, below the coffee belt, and in Pichucalco and Mezcalapa along the great Grijalva River clear down to Tabasco ; in the Papalopana and Tuxtepec Valleys clear up to the Rivers Tonto and Quiotepec, and the lands on the Gulf side of the Isthmus, covering an extension of 1,100 square miles, where the tree is found in astonishing numbers throughout the forests that skirt the Coatzacoalcos, Uspanapa, Coachapa, Chalchijapa, Del Corte, Chichibua, Malatengo, Sarabia, Jumuapa, Jaltepec, San Juan, Trinidad and Colorado Rivers.

Few are the plantations of rubber existing in the Republic, the principal one is "La Esmeralda," in Juquila, Oaxaca, which

has over 200,000 trees 8 years old, and the next is a plantation in the hacienda "Doña Felipa Ortiz," in Pichucalco, Chiapas, consisting of 10,000 trees 7 years old.

The hule tree belongs to the Urticaceæ, grows from 45 to 50 feet high, and has branches only at its upper section; has smooth yellow bark, its leaves are 6 to 10 inches long, oval, oblong, entire, thick, smooth, bright green, and glossy above. The umbrella-like form of the tree, which covers 10 feet square, is often seen among the mamey-zapote, striving to free itself, and rising majestically over the neighbouring trees. The tree is a hardy one, nothing affects it, not even parasites or animals. There are eight kinds of rubber tree that grow wild in the country, but the kind known under the name of (*Castilloa elastica*) is the most important and the best, as it is very much sought for its sap and for propagation; an example may be seen in the botanical garden of the preparatory school in this city.

The best soil for rubber cultivation is a deep, rich loam, such as is found along the alluvial banks of the above-mentioned rivers, and in the plains between the sea and the foot of the hills of the coast ranges.

Rubber is essentially a tropical tree; hence it requires a hot and moist climate. The temperature most adapted for its vigorous growth is about 86° Fahr., and the rainfall should be *at least 60 to 70 inches per annum*, however, salt air does not hurt it. A plot in the vicinity where natural trees are in abundance should be preferred for starting a plantation. Generally under favourable conditions the tree will there will grow faster, thicker, and consequently produce quicker results and a larger amount of juice.

In most cases the trees are found in the above places in sizes from seedlings to 18 and 36 inches in diameter. The tree propagates itself from the seed which drops from the tree, in the months of May and June, to the ground, and there watered and *nurtured by the warm rains*, which soon follow, the young plant some time after comes up to take its place, amongst the varied tropical life.

If the land set aside for the plantation is covered with trees, these must be felled and the undergrowth cleared only where the young trees are to be planted, providing no side planting is to be made. This work must be performed in the months of March and April, and immediately after, corn should be sown in the open spaces 15 inches apart. This operation is simply done by making a hole in the ground, dropping in a few grains, and covering over with *the foot*. Should the planter wish to adopt the most economic system, and thereby obtain the greatest return for the money invested, it would be advisable for him to plant besides corn

cotton, bananas, and coffee. But the attempt to plant Mocha coffee must not be made in elevations less than 1,000 feet above sea-level, neither on plains, nor where the temperature exceeds 85° Fahr.

In the latter case the acreage to be planted must be stubbed and the under brush forked in, or burnt before sowing the corn; then line and stake the plot in rows 15 feet apart. Peons who are posted in this kind of work, especially in coffee planting, have a long cord of rope (24 to 36 varas in length) on which they mark the divisions with inks made from dye-woods of the forests in these sections; the cord is held by two men, and another one marks the holes with his garrocha, leaving a stake in the excavated place every 15 feet in the row. This rule of setting the trees at such distance would ensure larger size and a greater flow of rubber-making fluid. As to shade, if the young plants have been taken from woods under shelter, then natural trees must be left on the plot before clearing to protect them from the strong rays of the sun until they are 10 or 12 feet high and have a prosperous appearance.

This must not be overlooked, as the plant will suffer a great deal from transplanting, even when that operation is done under the best circumstances. But if the young plants are obtained from unsheltered places, or from a nursery established in an open space, they having grown stronger and stouter will require no shelter, and will flourish more rapidly and vigorously than if they had shade.

If the seedlings or cuttings can be obtained within a few miles from a plot, it is advisable even to pay 2 dol. 50 c. per 100 rather than to wait 12 months for the seed to grow in the nursery. When the place, where the supply of young plants or cuttings is to be had is too distant, the expense of transportation would be enormous, and they would suffer to such an extent as to render them unfit and risky for transplanting; the only practical method in that case is to start a nursery. For this purpose a rich sandy loam should be selected. Beds are made 6 feet wide by 15 to 20 feet in length, leaving a walk 2 or 3 feet wide. The seeds are sown 8 inches apart in rows 10 inches distant one from another. This operation is done in the beginning of June or a few days after the rains have started, and by merely marking the ground, about an inch deep, with a stick, dropping the seed in and covering it with vegetable mould.

In 12 months the seedlings are about 24 inches high and ready for transplanting. All weeds and grass must be carefully removed with the hand from the bed as they appear and the earth watered when it seems dry, which is best done in the afternoon.

In the latter part of May or in the first days of June, when the rainy season commences, the seedlings, young plants, or cuttings are transplanted in the cleared plot between the corn and cotton, 15 feet each way. In removing the seedling or young plant as much of the original soil should be left attached to it, in accordance with the system known as "pilon." The earth must be opened sufficiently to place the plant at the same depth as in the seed bed, and then press down the earth with a spade so as not to leave any hollows around the tree. The plot planted with rubber trees should be inspected every now and then in order to know how they are progressing, and to replace the plants that have withered and died. In July or August it will be necessary to clean the corn, weed the plot, and after harvesting the corn, banana suckers (hijos) can be planted 7 feet apart between the rubber rows.

In Chiapas and Tabasco, cacao trees are set a few feet from the 2 or 3 year old rubber trees, the latter acting as shade for the former, in lieu of the regular madre protector or shade tree. Vanilla trees can be attached to the cacao tree, and by that means, after the lapse of 6 or 7 years, the planter has three or four different crops to harvest. Furthermore, bees could be raised on the place which would act as a medium to fertilise the vanilla flowers and give a handsome profit from honey and beeswax. Again, should the proprietor not want any side planting, cattle, which bring a good income in those sections, may be permitted to graze on the land as soon as the young trees are well rooted and have grown over 20 feet high. After going through the work of transplanting, the only care in the cultivation of the tree, thereafter, is that of keeping the ground free from all weeds and the rank vegetation of the tropics.

As to the expense and cost, the preparation and cultivation of an acre for 5 years, when a tree is ready for production, will require the services of a labourer working 51 days, or its equivalent of 51 labourers each working one day. The work consists of clearing the ground, so as to render it fit for general crops requiring 26 days; collecting the seedlings or cutting 193 trees, $1\frac{3}{4}$ days; planting same, $2\frac{1}{2}$ days; hoeing and staking 2 days; sowing corn, $1\frac{1}{2}$ days; harvesting same $1\frac{3}{4}$ day; planting banana suckers, $2\frac{1}{2}$ days establishing nursery, 1 day; and 5 years' cultivation, weeding, &c., 12 days. Estimating each day's labour at 50 c., it is seen that 193 trees on an acre of ground will have cost the planter at the time they are ready for planting less than 12 c. a piece. If a plantation of 100,000 trees is wanted, 517 to 529 acres or 5 caballerias of land will be required, and the total cost at the end of 5 years, exclusive of the first cost of the land, will be 12,000 dol. The wild land will cost from 1 dol. 50c. to 2 dol. per acre in small tracts; supposing that the 5

caballerias of land cost 1,200 dol., including the expense of drawing up documents, stamps, and recording; administration for 5 years, 5,000 dol.; gathering of the crop will be about 5 c. per tree or 5,000 dol. for 100,000 trees; gathering of banana bunches from $\frac{3}{4}$ to 1 c. per piece; collecting, drying, and sacking the cacao, $8\frac{1}{2}$ c. per lb.; collecting and curing vanilla beans 5 dol. per 1,000 pods; hence the total expense for the rubber plantation of 100,000 trees will not exceed 25,000 dol. Mexican currency.

Regarding the work of extracting the rubber, one man will tap from 20 to 25 trees per day if the operation is performed carefully and methodically. In most places the tapping is done in the month of May and sometimes again in October, but it is not advisable to repeat the operation as often as that. The process generally consists of making two or three incisions in the lower part of the trunk of the tree and collecting the sap that flows from them in clay vessels placed next to the trunk. Others make a spiral cup from 6 feet above the ground down the trunk of the tree, collect a portion of the juice at the bottom and the rest is allowed to dry in the concavity of the incision and later on is taken off. The best and most advisable system is to make low incisions.

The process can be repeated every year for 25 years or more, especially if the wound is covered with wax or clay after the flow of the sap has ceased. When there is a large quantity of milk gathered, it is dumped into a barrel having a faucet, and a solution of 5 ozs. of chloride or sub-carbonate of sodium in sufficient water to cover the whole mass, which is agitated with a stick every now and then. After the lapse of 24 to 36 hours the water is allowed to run out through the faucet, this operation of washing is done until the rubber becomes white.

About 44 per cent. of rubber remains, from the original amount of milk, after the water and other matters have been eliminated by evaporation.

Trees planted on lands having the soil, climate, and elevation adapted for the culture will produce from 5 to 6 lbs. of juice on the first year that thay are tapped, which amount is equivalent to 2·4 lbs. of pure rubber.

This product will be gradually increased every year for the next 4 or 5 years, and sell for 50 c., per lb. on the plantation. Thus 240,000 lbs., the yield of 100,000 trees at the first year's harvest, will bring the planter 120,000 dol. besides the product obtained from the corn, vanilla, bees, cacao, and bananas raised from side planting. The net profit on the investment, after deducting the entire cost of the land and all expenses up to the first year of harvesting, will be 95,000 dol.,

and each of the succeeding harvests for 25 or 30 years will bring a steady income of over 100,000 dol.

VI-EXTRACTS, NOTES AND QUERIES.

Experimental Morphology.*

In looking at the progress which has been made in the study of plant morphology, I have been as much impressed with the different attitudes of mind toward the subject during the past 150 years as by the advance which has taken place in methods of study, as well as the important acquisitions to botanical science. These different view points have coincided to some extent with distinct periods of time. What Sachs in his "History of Botany" calls "the new morphology" was ushered in near the middle of the present century by Von Mohl's researches in anatomy, by Naegeli's investigations of the cell, and Schleiden's history of the development of the flower. The leading idea in the study of morphology during this period was the inductive method for the purpose of discerning fundamental principles and laws, not simply the establishment of individual facts, which was especially characteristic of the earlier period when the dogma of the constancy of species prevailed.

The work of the "herbalists" had paved the way for the more logical study of plant members, by increasing a knowledge of species, though their work speedily degenerated into mere collections of material and tabulations of species with inadequate descriptions. Later, the advocates of metamorphosis and spiral growth had given an impetus more to the study of nature, though diluted with much poetry and too largely subservient to the imagination, and to pre-conceived or idealistic notions.

But it was reserved for Hoffmeister (1859), whose work followed within three decades of the beginning of this period, to add to the inductive method of research, as now laid down, the comparative method ; and extending his researches down into the Pteridophyta and Bryophyta, he not only established for these groups facts in sexuality which Camerarius and Robert Brown had done for the Spermatophyta, but he did it in a far superior manner. He thus laid the foundation for our present conceptions of the comparative morphology of plants. Naegeli's investigations of the cell had emphasized the importance of its study in development, and now the relation of cell growth to the form of plant members was carried to a high degree, and it was shown how dependent the form of the plant was on the growth of the apical cell in the Pteridophyta and Bryophyta, though later researches have modified this view ; and how necessary a knowledge of the

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sequence of cell division was to an understanding of homologies and relationships. Thus in developmental and comparative studies, morphology has been placed on a broader and more natural basis, and the homologies and relationships of organs between the lower and higher plants are better understood.

But the growth of comparative morphology has been accompanied by the interpretation of structures usually from a teleological standpoint, and in many cases with the innate propensity of the mind to look at nature in the light of the old idealistic theories of metamorphosis.

I wish now to inquire if we have not recently entered upon a new period in our study of comparative morphology. There are many important questions which comparative studies of development under natural or normal conditions alone, cannot afford a *sufficient number of data. We are constantly confronted with the* problems of the interpretation of structure and form, not only as to how it stands in relation to structures in other plants, which we deal with in comparative morphology, but the meaning of the structure or form itself, and in relation to the other structures of the organism, in relation to the environment, and in relation to the past. This must be met by an inquiry on our part as to why the structure or form is what it is, and what are the conditions which influence it. This we are accustomed to do by *experiment*, and it begins to appear that our final judgments upon many questions of morphology, especially those which relate to variation, homology, &c., must be formed after the evidence is obtained in this higher trial court, that of *experimental morphology*. While experimental morphology as a designation of one branch of research in plants, or as a distinct and important field of study, is not yet fully taken cognisance of by botanists, we have only to consult our recent literature to find evidence that this great and little-explored field has already been entered upon.

Experimental methods of research in the study of plants have been in vogue for some time, but chiefly by plant physiologists and largely from the standpoint of the physical and chemical activities of the plant, as well as those phases of nutrition and irritability, and of histrologic structure, which relate largely to the life processes of the plant, and in which the physiologist is therefore mainly interested. In recent years there has been a tendency in physiological research to limit the special scope of these investigations to those subjects of a physical and chemical nature. At the same time the study of the structure and behaviour of protoplasm is coming to be regarded as a morphological one, and while experimental methods of research applied to the morphology of protoplasm and the cell is comparatively new, there is already a considerable literature on the subject even upon the side of plant organisms. While certain of the phenomena of irritability and growth are closely related to the physics of plant life, they are

essentially morphologic ; and it is here especially that we have a voluminous literature based strictly on the inductions gained by experimentation, and for which we have chiefly to thank the physiologist.

If we were to write the full history of experimental morphology in its broadest aspect, we could not omit these important experimental researches on the lower plants in determining the ontogeny of polymorphic species of algæ and fungi which were so ably begun by DeBary, Tulasne, Pringsheim, and others, and carried on by a host of European and American botanists. The tone which these investigations gave to taxonomic botany has been felt in the study of the higher plants, by using to some extent the opportunities at botanic gardens where plants of a group may be grown under similar conditions for comparison, and in the establishment of alpine, subalpine and tropical stations for the purpose of studying the influence of climate on the form and variations *of plants, and in studying the effect of varying external conditions.*

While experimental morphology in its broadest sense also includes in its domain cellular morphology, and the changes resulting from the directive or taxic forces acccomanying growth, it is not these phases of morphology with which I wish to deal here.

The question is rather that of experimental morphology as applied to the interpretation of the modes of progress followed by members and organs in attaining their morphologic individuality, in the tracing of homologies, in the relation of members associated by antagonistic or correlative forces, the dependence of diversity of function in homologous members on external and internal forces, as well as the causes which determine the character of certain paternal or maternal structures. I shall deal more especially with the experimental evidence touching the relation of the members of the plant which has been represented under the concept of the leaf, as expressed in the metamorphosis theory of the idealistic morphology. The poetry and mystery of the plant world, which was so beautifully set forth in the writings of Goethe and A. Braun, are interesting and entrancing, and poetic communication *with Nature is elevating to our ethical and spiritual* natures. But fancy or poetry cannot guide us safely to the court of inquiry. We must sometimes lay these instincts aside and deal with Nature in a cold, experimental, calculating spirit.

The beginnings of experimental morphology were made about one century ago, when Knight, celebrated also for the impulse which he gave to experimental physiology, performed some very simple experiments on the potato plant. The underground shoots and tubers had been called roots until Hunter pointed out the fact that they were similar to stems. Knight tested the matter by experiment, and demonstrated that the tubers and underground stems could be made to grow into aerial leafy shoots. This he regarded as indicating a compensation of growth, and he thought,

further, that a compensation of growth could be shown to exist between the production of tubers and flowers on the potato plant. He reasoned that by the prevention of the development of the tubers the plant might be made to bloom. An early sort of potato was selected, one which rarely or never set flowers, and the shoots were potted with the earth well heaped up into a mound around the end of the shoot. When growth was well started, the soil was washed away from the shoot and the upper part of the roots. The tubers were prevented from growing, and numbers of flowers were formed. This result he also looked upon as indicating a compensation af growth between the flowers and tubers.

While we recognise Knight's experiments as of great importance, yet he erred in his interpretation of the results of this supposed correlation between the tubers and flowers, as Vöehting (1887, 1895) has shown. By repeating Knight's experiment, and also by growing shoots so that tubers would be prevented from developing, while at the same time the roots would be protected, flowers were obtained in the first case, while they were not not in the second; so that the compensation of growth, or correlation of growth, here exists between the vegetative portion of the plant and the flowers, instead of between the production of tubers and and flowers, as Knight supposed.

The theory of metamorphosis as expressed by Goethe and A. Braun, and applied to the leaf, regarded the leaf as a *concept* or *idea*. As Goebel points out, Braun did not look upon any one form as the typical one, which through transformation had developed the various leaf forms; but each one represented a wave in the march of the successive billows of a metamorphosis, the shoot manifesting successive repetitions or renewals of growth each season, presenting in order the "niederblätter, laubblätter, hochblätter, kelchblätter, blumenblätter, staubblätter fruchtblätter." Though it had been since suggested from time to time, as Goebel remarks, that the foliage leaf must be regarded as the original one from which all the other forms had arisen (at *that time Goebel did not think this the correct view*). No research, he says, had been carried on, not even in a single case, to determine this point. Goebel plainly showed, in the case of *Prunus Padus*, that axillary buds, which under normal conditions were formed one year with several bud scales, could be made by artificial treatment to develop during the first year. This he accomplished by removing all the leaves from small trees in April, and in some cases also cutting away the terminal shoot. In these cases the axillary shoots, instead of developing buds which remained dormant for one year, as in normal cases, at once began to grow and developed well-formed shoots. Instead of the usual number of bud scales, there were first two stipule-like outgrowths, and then fully expanded leaves were formed; so that in this case, he says, the metamorphosis of the leaf to bud scales was prevented

For this relation of bud scales to foliage leaves, Goebel proposed the term "correlation of growth." In the case of *Vicia faba*, removal of the lamina of the leaf of seedlings, when it was very young, caused the stipules to attain a large size, and to perform the function of the assimilating leaf. He points out that experimentation aids us in interpreting certain morphological phenomena which otherwise might remain obscure. He cites the occasional occurence ("Moquin-Tandon") in the open of enlarged stipules of this plant, which his experiment aids in interpreting. In the case of *Lathyrus aphaca*, the stipules are large and leaf-like, while the part which corresponds to the lamina of the leaf is in the form of a tendril, the correlation process here having brought about the enlargement of the stipules as the lamina of the leaf became adapted to another function. Kronfeld repeated some of Goebel's experiments, obtaining the same results, and extended them to other plants (*Pyrus Malus* and *Pisum sativum*), while negative results attended some other experiments. Hildebrand, in some experiments on seedlings and cuttings, found that external influences affected the leaves, and in some cases, where the cotyledons were cut, foliage leaves appeared in place of the usual bud scales. In *Oxalis rubella*, removal of the foliage leaf, which appears after the cotyledons, caused the first of the bulb scales, which normally appear following the foliage leaf, to expand into a foliage leaf.

In some experiments on the influence of light on the form of the leaves, Goebel has obtained some interesting results. Plants of *Campanula rotundifolia* were used. In this species the lower leaves are petioled and possess broadly-expanded, heart-shaped laminæ, while the upper leaves are narrow and sessile, with intergrading forms. Plants in different stages of growth were placed in a poorly lighted room. Young plants which had only the round leaves, under these conditions continued to develop only this form of leaf, while older plants which had both kinds of leaves when the experiment was started, now developed on the new growth of the shoot the round-leaved form. In the case of plants on which the flower shoot had already developed, side shoots with the round leaves were formed.

Excluding the possibility of other conditions having an influence here, the changes in the leaves have been shown to be due to a varying intensity of light. The situation of the plants in the open favour this view, since the leaves near the ground in these places are not so well lighted as the leaves higher up on the stem. In this case the effect of dampness is not taken into account by the experimenter, and since dampness does have an influence on the size of the leaf, it would seem that it might be at least one of the factors here. An attempt was now made to prevent the development of the round leaves on the young seedlings. For this purpose the plants were kept under the influence of strong and

continuous lighting. The round leaves were nevertheless developed in the early stage, an indication that this form of the leaf on the seedling has become fixed and is hereditary.

Having found that enclosing the larger cotyledon of *streptocarpus* in a plaster cast so as to check the growth, the smaller and usually fugacious one grew to the size of the large one, provided the experiment was started before the small one was too old. Amputation of the large cotyledon gave the same results.

Other experimenters have directed their attention to the effect of light and gravity on the arrangement of the leaves on the stem, as well as to the effect of light on the length of the petiole and breadth of the lamina. Among these may be mentioned the work of Weisse, Rosenvinge, and others.

Goebel has shown experimentally that dampness is also one of the *external influences which can change the character* of xerophyllous leaves. A New Zealand species of *Veronica* of xerophyllous habit and scaly appressed leaves, in the seedling stage has spreading leaves with a broad lamina. Older plants can be forced into this condition in which the leaves are expanded, by growing them in a moist vessel. Again, Askehasy and others have shown that dampness or dryness has an important influence in determining the character of the leaves.

The results of the experiments in showing the relation of the leaf to the bud scales, Goebel regards as evidence that the foliage leaf is the original form of the two, and that the bud scale is a modification of it.

Treub conducted some interesting experiments for the purpose of determining the homology of the pappus of the Compositæ.

Gall-insects were employed to stimulate the pappus of *Hieracium umbellatum*, and it was made to grow into a normal calyx with five lobes. A recent letter from Prof. Teub states that he later repeated these experiments with other species of Compositæ with like results, but the work was not published. Key found, in seedlings and cuttings which he experimented with, that while there was still stored food available for the roots and shoots, there was little if any dependence of one upon the other. Hering comes to somewhat different conclusions as a result of his experiments, finding that in some cases there was a slight increase of growth, while in others growth of the one was reciprocally retarded when the other was checked in development. Numerous cases of horticultural practice in pollination of fruits shows that the form and size of the fruit, and of the adjacent parts, as well as the longer or shorter period of existence of the floral envelopes, can be influenced by pollination.

The investigations carried on by Klebs in the conjugation of *Spirogyra* suggest how experimentation of this kind may be utilised to determine questions which in special cases cannot be arrived at easily by direct investigation. If threads of *Spirogyra varians*

which are ready for conjugation are brought into a 0·5 per cent. solution of agar-agar, in such a way that nearly parallel threads lie at a varying distance in their windings, where they are within certain limits, the conjugation tubes are developed and the zygospores are formed. But where the threads lie at too great a distance for the influences to be exerted, the cells remain sterile, and no conjugation tubes are developed. If now these threads be brought into a nutrient solution, the cells which were compelled to remain sterile grow and develop into new threads, *i.e.*, they take on the vegetative, though they are fully prepared for the sexual function. Strasburger has pointed out that this may be taken as excluding the possibility of there being a reducing division of the chromosomes during the maturing of the sexual cells, a process which takes place in animals, and that the behaviour of *Spirogyra* in this respect agrees with what is known to take place in the higher plants, *viz.* that the reduction process is not one which is concerned in the maturity of the gametes. The same could be said of *Polyphagus*, in which Nowakowski found that before the zygospore was completely formed the protoplasm moved out and formed a new sporangium.

In *Protosiphon botryoides*, Klebs was also able to compel the parthenogenetic development of the motile gametes, and the same thing was observed in the case of the gametes of *Ulothrix*. If we are justified in interpreting this phenomenon as Strasburger suggests, the evidence which Raciborski gives as a result of his experiments with *Basidiobolus ranarum* would support the idea that there is no reducing division in the chromosomes before the formation of the nuclei of the gametes. Raciborski found that the young zygospores of this species, in old nutrient medium where the fusion of the plasma contents had taken place, but before the nuclei had fused, if they were placed in a fresh nutrient medium the fusion of the nuclei was prevented, and vegetative growth took place, forming a hypha which possessed two nuclei—the paternal one and the maternal one. Raciborski interprets Eidam's study of the nuclear division prior to the copulation of the gametes as showing that the reducing division takes place here as in the maturation of the sexual cells of animals and looks upon the premature germination of the zygospore as showing that a paternal and maternal nucleus possesses the full peculiarities of a normal vegetative one. However, we are not justified in claiming a reducing division for the nuclei preceding the formation of the gametes in *Basidiobolus* from the work of Eidam, since he was not able to obtain sufficiently clear figures of the division to determine definitely how many divisions took place, to say nothing of the lack of definite information as to the number of chromosomes. Fairchild has recently studied more carefully the nuclear division, but, on account of the large number of the chromosomes, was not able to determine whether a reduction takes place. He points out, as others have

done, the similarity in the process of the formation of the conjugating cells of *Basidiobolus* and Mougeotia among the Mesocarpeæ, and to these there might be added the case of Sirogonium in which the paternal cell just prior to copulation undergoes division. The division of the copulation cells in *Basidiobolus Mougeotia, Sirogonium,* &c, suggest at least some sort of preparatory act; but whether this is for the purpose of a quantitative reduction of the kinoplasm, as Strasburger thinks sometimes takes place, or is a real reduction in the number of the chromosomes, must be determined by further study, so that the bearings of these experiments on the question of a reducing division must for the time be held in reserve.

One of the very interesting fields for experimental investigation is that upon the correlation processes which govern morphology of the sporophylls (stamens and pistils) of the Spermatophyta. One of the controlling influences seems to be that of nutrition, and in this respect there is some comparison to be made with the correlative processes which govern the determination of sex in plants. Among the ferns and some others of the Pteridophyta a number of experiments have been carried on by Prantl, Bauke, Heim, Buchtien and others to determine the conditions which influence the development of antheridia and archegonia. Prantl found that on the prothallia of the ferns grown in solutions lacking nitrogen there was no meristem, and consequently no archegonia, while antheridia were developed; but if the prothallia were changed to solution containing nitrogen, meristem and archegonia were developed. All the experiments agree in respect to nutrition; with scanty nutrition antheridia only were developed, while with abundant nutriment archegonia were also developed. Heim studied the influence of light, and found that fern prothallia grow best with light of 20 to 25 per cent. Exclusion of the ultra-violet rays does not affect the development of the sexual organs. He argues from this that the ultra-violet rays are not concerned in the elaboration of the material for flower production, as Sachs has suggested. In yellow light the prothallia grew little in breadth; they also grew upward, so that few of the rhizoids could reach the substratum. Antheridia were here very numerous. After seven months these prothallia were changed to normal light and in four months afterwards archegonia were developed.

Among the algæ Klebs has experimented especially with *Vaucheria*, such species as *V. repens* and *V. ornithocephala*, where the antheridia and oogonia are developed near each other on the same thread. With weak light, especially artificial light, the oogonium begins first to degenerate. He never succeeded in suppressing the antheridia and at the same time to produce oogonia.

High temperature, low air pressure or weak light, tend to suppress the oogonia, and at the same time the antheridia may increase so that the number in a group is quite large, while the

oogonium degenerates or develops vegetatively. Klebs concludes from his experiments that the causes which lie at the bottom of the origin of sex in *Vaucheria*, as in other organisms, are shrouded in the deepest mystery.

In the higher plants a number of experiments have been carried on for the purpose of learning the conditions which govern the production of staminate and pistillate flowers, or in other words the two kinds of sporophylls. From numerous empirical observations on diœcious Spermatophyta, the inference has generally been drawn that nutrition bears an important relation to the development of the staminate and pistillate flowers ; that scanty nutrition produces a preponderance of staminate plants, while an abundance of nutrition produces a preponderance of pistillate plants. For a period covering three decades several investigators have dealt with this question experimentally, notably K. Muller, Haberlandt and Hoffmann. These experiments in general give some support to the inferences from observation, yet the results indicate that other influences are also at work, for the ratios of preponderance either way are not large enough to argue for this influence alone. In a majority of cases thick sowings, which in reality correspond to scanty nutrition, tend to produce staminate plants ; while thin sowings tend to produce pistillate plants. In the case of the hemp (*Cannabis sativa*), Hoffmann found that these conditions had practically no influence. He suggests that the character of each may have been fixed during the development of the seed, or even that it may be due to late or early fecundation.

In monœcious plants it has often been observed that pistillate flowers change to staminate ones and *vice versâ*, and in diœcious plants pistillate ones sometimes are observed to change to staminate ones (the hemp for example, see Nagel, 1879). K. Muller states that by scanty nutrition the pistillate flowers of *Zea Mays* can be reduced to staminate ones.

Among the pines what are called androgynous cones have in some instances been observed. In *Pinus rigida* and *P. Thunbergii*, for example, they occur (Masters). Natsuda has described in the case of *Pinus densiflora* of Japan, pistillate and androgynous flowers which developed in place of the staminate flowers, and conversely staminate and androgynous flowers in place of pistillate ones. Fujii has observed that where the pistillate or androgynous flowers of *Pinus densiflora* occur in place of the staminate ones, they are usually limited to the long shoots which are developed from the short ones of the previous year. The proximity of those transformed short shoots (Kurztrieb) to injuries of the long ones, suggested that the cutting away of the long ones might induce the short ones to develop into long ones, and the flowers which were in the position for staminate ones to becomes pistillate.

Fujii says, "In fact, the injuries producing such effects are frequently given by Japanese gardeners to the shoots of the year

of *Pinus densiflora* in their operations of annual pollarding. But the 'Langtrieb' which is transformed from a 'Kurztrieb' of the last year does not necessarily bear female or hermaphrodite flowers in the positions of male flowers." To determine the influence of pollarding of the shoots he carried on experiments on this pine in the spring of 1895. He pollarded the shoots, so that, as he terms it, to induce the nourishment to be employed in the development of the flowers and short shoots near the seat of injury. In other cases one or two shoots were preserved while all the adjacent shoots of last year's growth at the top of the branch were removed, and, further, both of these processes were combined. Out of the forty-five branches experimented on, and on which there were no signs of previous injury, there were nine pistillate or androgynous flowers in place of staminate ones, in twenty-one branches with signs of previous injury, five were transformed, while in 2,283 not experimented on, and with no signs of previous injury, only seven were transformed. Such abnormal flowers, then, are due largely to the injuries upon the adjacent shoots, and Fujii thinks, largely to the increased amount of nourishment which is conveyed to them as a result of this.

From the experiments thus far conducted upon the determination of sex in plants or upon the determination of staminate or pistillate members of the flower, nutrition has at least some influence in building up the nourishing tissue for the two different organs or members. This can in part be explained on the ground that antheridia and staminate members of the plant are more or less short-lived in comparison with the archegonia and pistillate members, the latter requiring more bulk of tissue to serve the purpose of protection and nourishment to the egg and embryo. It is thus evident that while some progress has been made in the study of this question, we are far from a solution of it. Experiment has proceeded largely from a single standpoint, *viz.*, that of the influence of nutrition. Other factors should be taken into consideration, for there are evidently other external influences and internal forces which play an important *rôle*, as well as certain correlation processes perhaps connected with the osmotic activities of the cell sap.

The relation of the parts of the flower to the foliage leaves is a subject which has from time to time called forth discussion. That they are but modifications of the foliage leaf, or constituents of the leaf concept, is the contention of the metamorphosis theory, and that the so called sporophylls are modified foliage leaves is accepted with little hesitation by nearly all botanists, though it would be very difficult, it seems to me, for any one to present any very strong argument from a phylogenetic standpoint in favour of the foliage leaf being the primary form in its evolution on the sporophyte and that the sporophyll is a modern adaptation of the foliage leaf. Numerous cases are known of

intermediate forms between sporophylls and foliage leaves both in the Spermatophyta and Pteridophyta. These are sometimes regarded as showing reversion, or indicating atavism, or in the case of some of the ferns, as being contracted and partially fertile conditions of the foliage leaf. There has been a great deal of speculation regarding these interesting abnormal forms, but very little experimentation to determine the causes or conditions which govern the processes.

In 1894 I succeeded in producing a large series of these intermediate forms in the sensitive fern (*Onoclea sensibilis*). The experiments were carried on at the time for the especial purpose of determining whether in this species the partially developed sporophyll could be made to change to a foliage leaf, and yet possess characters which would identify it as a transformed sporophyll. The experiments were carried on where there were a large number of the fern plants. When the first foliage leaves were about 25 cm. high, they were cut away (about the middle of May). The second crop of foliage leaves was also cut away when they were about the same height during the month of June. During July, at the time that the uninjured ferns were developing the normal sporophylls, those which were experimented upon presented a large series of gradations between the normal sporophyll and fully expanded foliage leaves. Among these examples there are all intermediate stages from sporophylls which show very slight expansions of the distal portion of the sporophyll, and the distal portions of the pinnæ, until we reach forms which it is very difficult to distinguish from the normal foliage leaf. Accompanying these changes are all stages in the sterilisation of the sporangia (and the formation of prothalloid growths), on the more broadly expanded sporophylls there being only faint evidences of the indusia.

The following year (1895) similar experiments were carried on with the ostrich fern (*Onoclea struthiopteris*), and similar results were obtained. At the time that these experiments were conducted, I was unaware of the experiments performed by Goebel on the ostrich fern. The results he reached were the same; the sporophyll was more or less completely transformed to a foliage leaf. Goebel regards this as the result of the correlation process, and looks upon it as indicating that the sporophyll is a transformed foliage leaf, and that the experiment proves the reality here of the modification which was suggested in the theory of metamorphosis, and thus the foliage leaf is looked upon by him as the primary form. Another interpretation has been given to those results, *viz.* that they strengthen the view that the sporophyll, from a phylogenetic standpoint, is primary, while the foliage leaf is secondary. What one interprets as a reversion, another regards as indicating a mode of progress in the sterilisation of potentiality, sporogenous tissue, and its conversion into

assimilatory tissue. It is perhaps rather to be explained by the adaptive equipoise of the correlative process existing between the vegetative and fruiting portions of the plant which is inherited from earlier times. Rather when spore-production appears on the sporophyte could this process be looked upon as a reversion to the primary office of the sporophyte, so that in spore-production of the higher plants we may have a constantly recurring reversion to a process which in the remote past was the sole function of this phase of the plant. In this way might be explained those cases where sporangia occur on the normal foliage leaf of *Botrychium*, and some peculiar cases which I have observed in *Osmunda cinnamomea*. In some of the examples of this species it would appear that growth of the leaf was marked by three different periods even after the fundament was outlined; the first, a vegetative; second, a spore-producing; and third a vegetative again; for the basal portions of the leaf are expanded, the middle portions spore-bearing, the passage into the middle portions being gradual, so that many sporangia are on margins of quite well-developed pinnæ. These gradations of the basal part of the leaf, and their relation to the expanded vegetative basal portion, showing that the transition here has been from partially formed foliage leaf to sporophyll after the fundament was established, and later the increments of the vegetative part from the middle towards the terminal portion, shown by the more and more expanded condition of the lamina and decreasing sporangia, indicate that vegetative forces are again in the ascendency. This suggests how unstable is the poise between the vegetative leaf and sporophyll in structure and function in the case of this species.

For two successive years I have endeavoured by experiment to produce this transformation in *Osmunda cinnamomea*, but thus far without sufficiently marked results. The stem of the plant is stout, and this, together with the bases of the leaves closely overlapping, contain considerable amounts of stored nutriment which make it difficult to produce the results by simply cutting off the foliage leaves. The fact that these transformations are known to occur where fire has overspread the ground, and, as I have observed, where the logging in the woods seriously injured the stools of the plant, it would seem that deeper-seated injuries than the mere removal of foliage leaves would be required to produce the transformation in this species. It may be that such injury as results from fire or the severe crushing of the stools of the plant would be sufficient to disturb the equilibrium which existed at the time, that the action of the correlative forces is changed thereby, and there would be a tendency for the partially developed foliage leaves to form sporangia, then when growth has proceeded for a time this balance is again changed.

The theory that the foliage leaves of the sporophyte have been derived by a process of sterilisation, and that the transformation of

sporophylls to foliage leaves, in an individual, indicates the mode of progress in this sterilisation, does not necessarily involve the idea that the sporophyll of any of the ferns, as they now exist, was the primary form of the leaf in that species ; and that by sterilisation, of some of the sporophylls, the present dimorphic form of the leaves was brought about. The process of the evolution of the leaf has probably been a gradual one, and extends back to some ancestral form now totally unknown. One might differ from Prof. Bower; the examples selected by him to illustrate the course of progress from a simple and slightly differentiated sporophyte to that exhibited in the various groups of the Pteridophyta. But it seems to me that he is right in so far as his contention for the evolution of vegetative and assimilatory members of the sporophyte, can be illustrated by a comparison of the different degrees of complexity represented by it in different groups and, that this illustrates the mode of progress, as he terms it, in the sterilisation of potential sporogenous tissue.

On this point it appears that Prof. Bower has been justly criticised. The forms selected to illustrate his theory were chosen not to represent ancestral forms, or direct phylogenetic lines, but solely for the purpose of illustrating the gradual transference of spore-bearing tissue from a central to a peripheral position, and the gradual eruption and separation of spore-bearing areas, with the final sterilisation of some of these outgrowths.

To maintain that in phylogeny the sporophyll is a transformed foliage leaf, would necessitate the predication of ancestral plants with only foliage leaves, and that in the case of these plants the vegetative condition of the sporophyte was the primary one, spore production being a later developed function. Of the forms below the Pteridophyta, so far as our present evidence goes, the sporophyte originated through what Bower calls the gradual elaboration of the zygote. All through the Bryophyta wherever a sporophyte is developed, spore production constantly recurs in each cycle of the development, and yet there is no indication of any foliage organs on the sporophyte. The simplest forms of the sporophyte contain no assimilatory tissue, but in the more complex forms assimilatory tissue is developed to some extent, showing that the correlative forces which formerly were so balanced as to confine the vegetative growth to the gamophyte and fruiting to the sporophyte, are later changing so that vegetative growth and assimilation are being transferred to the sporophyte, while the latter still retains the function of spore production, though postponed in the ontogeny of the plant.

If we cannot accept some such theory for the origin of sporophylls and foliage leaves by gradual changes in potential sporogenous tissue, somewhat on the lines indicated by Bower, it seems to me it would be necessary, as already suggested, to

predicate an ancestral form for the Pteridophyta in which spore production was absent. That is, spore production in the sporophyte of ancestral forms of the Pteridophyta may never have existed in the early period of its evolution, and spore production may have been a later development. But this, judging from the evidence which we have, is improbable, since the gametophyte alone would then be concerned in transmitting hereditary characters, unless the sporophyte through a long period developed the gametophyte stage through apospory. Bower says, in taking issue with Goebel's statement that the experiments on *Onoclea* prove the sporophyll to be a transformed foliage leaf: "I assert on the other hand, that this is not proved, and that a good case could be made out for priority of the sporophyte; in which event the conclusion would need to be inverted, the foliage leaf would be looked upon as a sterilised sporophyll. This would be perfectly consistent with the correlation demonstrated by Prof. Goebel's experiments, as also with the intercalation of a vegetative phase between the zygote and the production of spores." In another place he says: "To me whether we take such simple cases as the Lycopods or the more complex case of the Filicineæ the sporangium is not a gift showered by a bountiful Providence upon pre-existent foliage leaves: the sporangium, like other parts, must be looked upon from the point of view of descent; its production in the individual or in the race may be deferred, owing to the intercalation of a vegetative phase, as above explained; while, in certain cases at least, we probably see in the foliage leaf the result of the sterilisation of sporophylls. If this be so, much may be then said in favour of the view that the appearance of sporangia upon the later formed leaves of the individual is a reversion to a more ancient type rather than a metamorphosis of a progressive order."

As I have endeavoured to point out in another place, if a disturbance of these correlative processes results in the transference of sporophyllary organs to vegetative ones on the sporophyte, why should there not be a similar influence brought to bear on the sporophyte, when the same function resides solely in the gametophyte, and a disturbing element of this kind is introduced? To me there are convicing grounds for believing that this influence was a very potent—though not the only—one in the early evolution of sporophytic assimilatory organs. By this I do not mean that in the Bryophyta, for example, injury to the gametophyte would now produce distinct vegetative organs on the sporophyte, which would tend to make it independent of the gametophyte. But that in the bryophyte-like ancestors of the pteridophytes an influence of this kind did actually take place, appears to me reasonable.

"In the gradual passage from an aquatic life, for which the gametophyte was better suited, to a terrestrial existence for which

it was unadapted, a disturbance of the correlative processes was introduced. This would not only assist in the sterilisation of *some of the sporogenous tissue*, which was taking place, but there would also be a tendency to force this function on some of the sterilised portions of the sporophyte, and to expand them into organs better adapted to this office. As eruptions in the mass *of sporogenous tissue took place*, and sporophylls were evolved, this would be accompanied by the transference of the assimilatory function of the gametophyte to some of these sporophylls."

Because sporophytic vegetation is more suited to dry land *conditions than the gametophytic vegetation, it has come to be* the dominating feature of land areas. Because the sporophyte in the Pteridophyta and Spermatophyta leads an independent existence from the gametophyte, it must possess assimilatory tissue of its own, and this is necessarily developed *first in the ontogeny;* but it does not necessarily follow, therefore, that the foliage leaf was the primary organ in the phylogeny of the sporophyte. The provision for the development of a large number of spores in the thallophytes, *so that many may perish and still some remain to* prepetuate the race, is laid hold on by the bryophytes, where the mass of spore-bearing cells increases and becomes more stable, for purposes of the greatest importance. Instead of perishing, some *of the sporogenous tissue forms protecting envelopes, then sup*porting and conducting tissue, and finally in the pteridophytes and spermatophytes nutritive and assimilatory structures are developed. Nature is prodigal in the production of initial elementary *structures and organs. But while making abundant* provision for the life of the organism through the favoured few, she has learned to turn an increasing number of the unfavoured ones to good account. Acted upon by external agents and by internal forces, and a changing environment, advance is made, step by step, to higher, more stable, and prolonged periods.

While we have not yet solved any one of these problems, the results of experimental morphology are sufficient to indicate the great importance of the subject and the need of fuller data from a much larger number of plants. If thus far the results of experiments have not been in all cases sufficient to overthrow the previous notion entertained touching the subjects involved, they at least show that there are good grounds for new thoughts and new interpretations or for the amendment of the existing theories. While there is not time for detailing even briefly another line of experiment, *viz.* that upon leaf arrangement, I might simply call attention to the importance of the experiment conducted by Schumann and Weisse from the standpoint of Schwendener's mechanical theory of leaf arrangement. Weisse shows that the validity of the so-called theory of the spiral arrangement of the leaves on the axis may be questioned, and that there are good grounds for the opening of the discussion again. It seems to me, therefore, that the final

judgment upon either side of all these questions cannot now be given. It is for the purpose of bringing fresh to the minds of the working botanists the importance of the experimental method in dealing with these problems of nature that this discussion is presented as a short contribution to the subject of experimental morphology of plants.

British Woods and Forests.

The annual report of the office of Woods and Forests has just been issued, and is more up to date than the average Blue Book of a Government Department. The Commissioners have come to the conclusion that the system of forest management which was in vogue in State woodlands, when the object was to grow oak for the Royal Navy, is no longer applicable now that for some thirty years ships of war have been built of steel backed by teak and other hard foreign woods. Perhaps it is a little remarkable that the present Commissioners, who are quite *novi homines*, at the Office of Woods, should have been left to make this discovery, Better late than never, however, and we heartily welcome the appointment of Mr. Hill to see how the Governmet forests can be made to pay a good profit. Mr. Hill has had great experience in the eminently practical Forest Department of India, and it is probable that he will be able to recommend the intermixture of the oak woods with other sorts of timber. The demand for all timber has so much improved of the last eighteen months, that the Office of Woods show very satisfactory returns ; but this demand is fluctuating, and of course the Government had no advantages in the open market over any other grower. We foresee that the question of beauty will not be entirely forgotten in any gradual re-planting of the forests belonging to the State.—*The Graphic.*

Pine Wood at the Cape.

GENADENDAL REVISITED.

By the Conservtor or Forests.

It is worth a long journey to Genadendal to witness the natural regeneration of the cluster-pine. Between 1825 and

1830, *i. e.*, about seventy years ago, a small area at the foot of the mountain near the picturesque old church-yard was trenched and sown with cluster-pine seed. None of these seventy-year-old pines now remain, though one or two of their broad stems can still be identified. From these trees the cluster-pine has spread, self-sown, up the rocky face of the mountain and into the rugged Genadendal valley, presenting most picturesque and remarkable effects: now subduing the moorland veld, and anon covering with ample humus the bare rocks. No sight has so impressed me since my first view of Table Mountain from a Wynberg window at daybreak on a serene winter's morning. The Genadendal Valley runs into the heart of the highlands for four or five miles. To the east rises the Genadendal Mountain, 5,000 feet high. From this valley issues the stream that waters the station, and some distance upon both sides of the water, extend these natural woods of cluster-pine, unsurpassed in their sylvan beauty and in their lesson of potential forest wealth by anything else at a distance from Table Mountain. Mr. Vedemann pointed out to me a spot on the east side of the valley where, when he left Genadendal in 1881, there was only a scattered growth of pine which was traversed by a veld fire five years afterwards, in 1886. Nevertheless the whole of this area is now covered with a sufficient stock of young self-sown pine, with larger pines scattered among them, showing by their blackened stems where the fire has passed. On the west side of the valley the pine woods are intersected by winding paths. It is necessary from time to time to clear these paths of the young pines, which would otherwise soon obliterate them. Wherever any opening lets in a little light, young pines make their appearance, exactly as in a Scotch-pine forest in Europe.

I saw a coupe of about three acres clean cut two years ago. It is already nearly completely re-stocked, and by next season the seed from the adjoining old trees will have completed the natural regeneration. An adjoining coupe, also clean-cut four years ago, is now completely re-stocked with a dense growth of young pine, averaging ten or so to the square foot. On the Mission lands near the pine forest, cluster-pine spreads everywhere. I was shown a brick kiln, where the bricks for the new church were burnt five years ago, now covered with a growth of young pines. The adjoining churchyard was cleaned of young pines three years ago. It is now covered with a dense pine regrowth, and must be again cleared. Cluster-pine is indeed invasive everywhere and on every soil—clay, loam, rock, or sand. The process by which the cluster-pine conquers the tenacious vegetation of the veld and spreads up the mountain in spite of the fires seems to be something like this. The

old pine trees bear heavy masses of cones, and the light-winged seed is shed abundantly and flies far. Some of this germinates on rocky places where there is no veld vegetation to feed the fires. One can see single trees and little patches of pines spreading up the mountain in this way. Such trees escape the veld fires which killed off the better trees on better ground. It is in this way that the cedar has maintained itself on the Cedarberg. Similar patches of pine on rock may be observed on certain spots on the slopes of Table Mountain. Where the forest tree is sufficiently powerful, the sequel is simply a question of time. The trees on the rocky ground grow up, and by their shade and leaf droppings kill the veld around. Then on the clean fire-safe soil spring up other pines in ever-widening circles.

Fire.

There have been several scares of fire, and small areas burnt since 1830, but no severe fires, nor any that have inflicted permanent injury to the woods. As in Gascony, the usual sequence of a fire is a dense, regular regrowth of young pines. The only exception I saw to this rule was where the neighbouring pines were too young to shed seed. Mr. Vedemann considers that even the seed of young pines has not the same germinative power as that of old trees. Anyhow, it would seem to be a wise precaution, in the regular treatment of cluster-pine forest, to make the coupes long, narrow, and non-consecutive. The small and irregular coupes on the slopes of Table Mountain serve the same end. The veld at Genadendal is usually burnt every second year, and precautions are taken to prevent veld fires spreading to the pine woods. Should fire get in, it is only young pines in the thicket stage that are much endangered, and they seem, at Genadendal, to soon shed their lower branches and become clean and safe. Fire runs along the pine-needles on the ground, but such fires are easily put out. Old trees with their thick bark are not damaged by ordinary fires. The low branching trees of sparse forest suffer the most. Fire runs up their foliage, which, says Mr. Vedemann, burns in summer like pitch. Some of the small, irregular plantations on private lands at Genadendal have suffered severely from fire.

Advance Growth.

As in Gascony, the advance growth is worthless. It seems to be more abundant than in the Cape Peninsula, but is invariably twisted, drawn, and weak. Nevertheless, a fact I noticed in one place seems to show that the cluster-pine in South Africa is not quite such a strong light-demander as in Europe. Under an oak plantation where there would be a good deal of light

in winter, with the leaves off, I noticed an under-growth of cluster-pine, with the stems straight and perhaps fit for a future stock if the oak were removed. Undoubtedly, says Mr. Vedemann, if the pine be left to itself here it will pierce, dominate, and kill the oak.

Growth.

The cluster-pine at Genadendal has a clean, straight, robust growth that is unsurpassed by the best trees in the Cape Peninsula. Trees as straight as a mast and 70 feet to the first branch are not uncommon, especially in that part of the forest where the want of a bridge has prevented over-thinning. I measured one mast-like stem as it lay on the ground. It had been cut off at 102 feet, and had probably a total height of 10 or 15 feet more, say 114 feet total height. Among the trees growing on bare rock an occasional one sometimes dies, but its place is immediately filled by others. There was no appearance of disease of any sort, the trees being uniformly clean and healthy as in the Cape Peninsula.

Treatment.

Clean cutting is practised except where it is necessary to preserve the trees for shelter. There jardinage or selection felling is followed. Irregular thinnings are also allowed ; (*a*) Of choice trees ; (*b*) of crooked or badly grown trees. Under (*a*) picked trees are taken for scaffolding, bridging, or any special purpose. The practice is justified on grounds of expediency and economy, looking at the smallness of the pine forest and the irregular demand. But it does not improve the stock which is everywhere over-thinned and too open, except where the want of a bridge has hindered the extraction of timber. The clean-cutting in small coupes gives excellent results, and is evidently the right treatment. The thinnings should be curtailed or suspended and obviously under (*a*) restricted as far as may be, if the forest is to be brought to its best development.

Utilisation of Timber.

At Genadendal cluster-pine timber is used for all the purposes where imported pine is employed in Cape Town, except for fine carpentry. In all the various buildings, and there are some large substantial houses, a church, and a mill of three stories, I saw nothing but cluster pine. It is cluster-pine everywhere here, as it is cedar everywhere in the farms of the Cedarberg country. Cluster-pine answers well for floors, joists, and beams ; but for fine carpentry, such as

windows, its hard, resinous nature makes it difficult to work. I noticed that woodwork left unpainted or not oiled becomes worm-eaten, even indoors. But waxed flooring boards showed no decay, and though sawn very wide—up to 18 inches wide—do not warp. I saw nothing but cluster-pine flooring, but I understand that imported flooring boards have occasionally been used.

The clusterpine woods at Genadendal are too open to produce the best timber, especially when young. This is seen not only in the forest, but in the structure of the timber when cut. Some sections I examined showed two rings per inch of radius at the centre, and twenty rings near the bark! It is easy for the forester to improve on wood of this coarse and uneven texture. By better regulated trimmings he can produce wood that will be fine in the grain, of even texture, and free from knots.

When used out of doors cluster-pine is protected at Genadendal with carbolineum. Water-seasoned blue-gum wood is similarly protected with carbolineum. This is made in Stuttgart and costs in Germany about 2s. the gallon. Imported direct it costs about 4s. the gallon in Genadendal. it is said that there is unfortunately a high duty on this useful material. At Genadendal the carbolineum is applied hot to the dry wood. It fills up all the cracks and goes deep enough into the wood to form a really protective surface.

For such a purpose as barrows, cluster-pine is held to be inferior to poplar. Cluster-pine is a hard strong wood, but not elastic like poplar. When cluster-pine gives way it breaks off short.

At Genadendal the cluster-pine timber is brought to the side of the road and there sold to the farmers, who come with their wagons and fetch it away. Prices are low. A sound straight log 9 inches diameter and 22 feet long would be sold for 3s. Scaffold poles 4 inches mean diameter and 36 feet long sell for 9d. I measured a round log as it lay on the ground, 90 feet in length. I was told it was for a farmer who wants to cut planks 14 inches by 23 feet. I saw a pile of sawn wood—2-inch planks and quartering—well stacked and ventilated. It is excellent wood, but somewhat knotty, owing to the open condition of the forest. Mr. Vedemann thinks cluster-pine less liable to get worm-eaten than yellow wood. There is little fear of worms, he adds if the wood be cut in season. The practice at Genadendal is to cut cluster-pine all the year round, but always when the moon is down. On this point Mr. Vedemann, the missionary, is emphatic, and says he has amply proved by experience that wood felled when the moon is down is better to work and lasts better—is less liable to get worm-eaten. He would prefer to cut also in winter,

but farmers come to buy at all seasons of the year, and he has no arrangements for storing.

Cluster-pine in the South.

The extended planting of cluster-pine in the southern and south-western districts has long been advocated by the Forest Department. All along the better watered south-western coast districts, it exists as a hardy forest tree, requiring for its propagation only that the ground be ploughed or otherwise broken up and sown at the proper season, *i.e.*, with the first winter rains. No plantations in South Africa, and few in other parts of the world, can be laid down so cheaply and so easily. It is as simple as sowing a field of wheat or oats. A good bushel of seed, or about forty pounds to the acre, is required. The seed costs from 3d. to 4d. a lb., *i.e.*, it can be obtained at this price from Government. It is imported in large quantities (from eight to ten tons yearly) by the Forest Department for Government use, and in order to assist tree-planting generally. Such as can be procured from local sources is collected, but local seed costs 6d. per lb., while it can be imported from Italy and France at from 3d. to 4d. per lb.

The results at Genadendal are the demonstration of the practical utility of what has been done to propagate cluster-pine. After many years' trial and experience in the Government plantation, with all the pines in the world likely to come into competition with it, nothing, so far, has been obtained to seriously compete in the south-west with cluster-pine, the tree that in transforming the fever-stricken marshes of Gascony has literally given a fertile province to France; and the tree which, even among all the noble conifers of California is preferred there for re-planting purposes.

Those who may wish to see the cluster-pine growing near Cape Town should visit the Government plantations at Uitvlugt and Tokai, or the wind-swept slopes of the mountain above Woodstock. At Ceres-road it may be seen shooting sturdily where simply sown on a poor gravelly ridge. On the barren sour-veld moorland at Knysna, where so little else will grow, cluster-pine can be seen flourishing marvellously. In the Government plantations at Concordia it has supplanted all other trees.

A Great Future.

The country must have pine plantations. Dr. Schlich, in a recent able paper read before the Imperial Institute, has shown how the pine timber supplies of the world are reaching a visible termination. The present importation of pine wood

to South Africa must considerably exceed in value a quarter of a million pounds sterling. During 1896 the quantity of pine wood and wood of that class entered at the ports of Cape Colony amounted to 4,967 cubic feet, valued at £215,693. It is certain that cluster-pine, properly grown in close plantations (and this is a very important and imperative proviso) would supply the greater part of the present demand for pine wood. At present we have the pick of the pine forests of the world at prices so low that they cannot last long. In the future there is a certain market for Colonial pine wood, And, just as the the worthy missionaries at Genadendal are now thanking the foresight of their predecessors in planting the cluster-pine seventy years ago, so in another forty years will the Colonist of the future be indebted to those who plant cluster-pine now.

Speaking of cluster-pine plantations, it was shown in my last annual report that for every £1 spent now the country should reap an annual revenue of £1 in thirty-five or forty years. And, perhaps even better than this, the quarter of a million pounds sterling or more, now paid yearly to the foreigner. It has been computed that nine-tenths of all the wood used in the world is pine, or wood of that class.—*Cape Times.*

D. E. HUTCHINS.

THE

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Note on the Forest School Tour in Oudh.

BY F. GLEADOW.

Arrangement of the Tour—Students travel with concession tickets, which have to be applied for in good time, say early in December, from the Traffic Superintendents of the various lines travelled over. These tickets do not allow holders to travel by mail or (generally) passenger trains, and as each Company does its best by inconvenient timing and delays, to keep passengers from using rival lines, the result is vexation and loss of time. The Mail from Saharanpore reaches Bareilly at 6-39, but the train that ought to correspond is sent off at 5-10, and the unfortunate passengers have to wait till 16-33. The Mixed reaches Bareilly at 1-35 a. m. and catches the 5-10 above mentioned. The Passenger reaches Bareilly at 18-24, but naturally fails to catch the 16-33 and travellers have to stay the night and go by the 5-10. On the return journey from Mailani the Mail is convenient enough, but the Mixed gets into Bareilly at 9-20 leaving passengers the option of taking the 18-27, the same day, or the 6-50 the day after. At Mailani there is another change, as Sonaripur is the terminus of the Dudwa Branch. On our arrival, the Branch, not used in the rains, was not yet open, but exertions had been made to get it open, and the line having been duly inspected the day after our arrival, the Rohilkhand-Kumaon Railway very kindly ran a train a day earlier than was intended, no doubt at considerable inconvenience to themselves, a favour which was appreciated greatly.

Another important point is the provisioning of the camp. There are no villages with banias' shops convenient, so a bania is attached to the camp, and this makes it necessary to ascertain how much of each kind of food, &c., the students will require per day for a certain number of days. This information should reach the Divisional Forest officer, Lakhimpur, before Christmas, so that he may make adequate arrangements.

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Tents have to be taken, which is another difficulty. They are sent in advance by goods train during Christmas week, which is easy enough, but as they are not wanted at Lahore, they have to be returned from Oudh to Saharanpur. I was indeed hospitably housed in bungalows, but these may be otherwise occupied, and do not exist everywhere. Coupes are very large and though next year the same camps will do, it will not always be possible to find houses within reach of the work. The forests seen are often densely grassed and without people or cattle, so that short cuts across country are rare. It is a case of going miles round by road, or of forcing a way with greater exertion and little or no saving of time. In fact, it is largely elephant forest, in which a man on foot is at a disadvantage in using either his legs or his eyes.

We were unable to return, as originally intended, on the 12th, as one of the piles was washed out of the Sarda bridge, and trains ceased running till 15th January.

Next year, it will be better to delay this tour till after the Punjab visit and so not only find the depôts in full work, but avoid the chance of a difficult year like the present interrupting the regular course of the arrangements. We are greatly indebted to the Divisional Officer, Mr. J. C. Tulloch, not only for complete information, instantly available on demand, but for managing our supply and transport both by rail and road in so satisfactory a manner.

January 5th, 1898. Roll call at Mailani, whither the students found their own way, partly from Dehra Dún, and partly from their homes.

January 6th. At Mailani. Visited the Marha Working Circle of the Kheri Division. It is partly high forest under improvement fellings, but the part we inspected was the coppice with standard area. It is yet only in process of conversion from the original irregular high forest. The crop is of mixed species, mostly sal, with sain and a few various. The forest is on a flat plain of alluvium, with very slight elevations and depressions. The water level in the hot weather averages 12ft. below the surface. The vegetable soil containing humus is generally 2in. occasionally 6in. deep. The elevation averages 555ft above sea level. The rainfall varies from 45 to 54 inches.

The Working Plan began from 1893-94. The rotation is only 24 years, because the principal market, the railway, takes nothing over 9 in. in diameter. The area of the coppice Working Circle is 23,500 acres stocked and nearly 6,000 unstocked. There were no fellings in coupe No. 3 last year, as the railway ceased taking fuel owing to a dispute, they having without warning declined to accept anything but sal. On reference to government, they had to take the wood refused, but in future they take sal only, which may be to their own interest, but is certainly not to the interest of the country. This year, therefore, two coupes were felled, No. 3 containing 840 acres stocked and 186 unstocked,

and No. 4, of 897 stocked and 105 unstocked. No. 5 is being marked for next year. The coupes are marked by the Department, sold by tender and cut by purchasers. The contractor cuts every thing flush with the ground and is supposed to coppice all stools, but the stumps are not yet smoothed and frequently quite concave. In fact coppicing is as yet a new idea to the people and they are still grappling with it. Felling begins about November, finishing 15th June. All sal 3'-9" in diameter goes to the Railway, the balance to Lucknow and Bareilly for brick burning. The regular length is 2½ft. the thick pieces being split at destination. The maximum reservation of standards is fixed at 75 stems of class V (up to 6" diam.) or 50 stems of class IV (6" to 12" diam.) which gives a distance apart of 24ft. and 30ft. respectively. The number actually reserved is 57·7 per acre.

During the felling, 10 per cent., of the area is re-counted to see that the correct number of standards is kept as per Working Plan. Standards are kept for 3 rotations only, *viz.* 24,48, and 72 years, as after that age they become hollow. Though the crop is mostly sal and sain (*Terminalia tomentosa*) it is not always possible to secure an even distribution of standards with these two species. As the locality suffers from frost, this is an important point, and to secure it inferior species, such as *Terminalia Belerica*, and even *Odina Wodier*, are occasionally, but quite exceptionally, reserved. The forest has never been treated before, except by the extraction of trees irregularly as required. The forest is a dense growth of medium size, with plenty of underwood of shade-bearing shrubs, &c. There are numerous "*chāndas*" or grass areas, totalling about ⅓rd of the whole forest. These are slowly filling up with sal, notwithstanding the fact that frost kills off most of the plants as soon as they top the grass. We saw vast expanses of grass containing an almost equal quantity of young sal, all killed outright and brown. In a few scattered spots, plants are safe at 6-8 ft high, but mostly, on low ground or poor soil, they are not safe till they reach 15 or more feet high The system of strip fellings, 30 ft. broad, with 60 ft. of forest between, was tried in Gola but abandoned, as all the young plants were killed by frost.

The rate of growth from 1881 to 1891 for the coppice area was obtained from two sample plots of 1 acre and ¼ acre respectively, far too small to give reliable results, as follows :—

V Class,	up to 6 in. diam.	gave	·544	inches per year on the girth
IV ,,	6 in.—12 in.	,,	·617	
III ,,	12 in.—18 in.	,,	·?62	(from 5 trees)
II ,,	18 in.—24 in,	,,	447	(1 tree only)

Two other small plots in the high forest area gave :

V Class=·510, IV Class=·462, III Class=(7 trees)=·573, II Class (3 trees)=·625.

These figures suggest a rotation of 33 years, but it was not adopted, because certain clean fellings showed that the growth was faster. Forest land had been given out to grantees, who made these clean fellings, but failed to cultivate, so the land was resumed, and it was found that areas felled 20-30 years previously were covered with trees 18 to 24 in. in girth.

We measured some sal trees, to find the heights corresponding to different girths, and found.

Girth	Height	Girth	Height
15 in.	27 ft.	30 in.	51 ft.
17 „	35 „	30 „	51½ „
19 „	37 „	32½ „	60 „
26 „	55 „	35 „	65 „
27 „	50 „	36 „	57 „
29 „	47½ „	37½ „	55 „
29½ „	55 „	42 „	60 „
29½ „	55½ „		

There are no rights or privileges in the Coppice area, but the grazing question is important here as elsewhere, and is met in the high forest area. Even there, there are no rights, but only concessions. The grazing is on passes, at privileged rates, 2 as. per cow and 4 as. per buffalo, against 4 as. and 10 as. market rates, per year, and there is no close season. The concession extends to all villages within 3 miles of the forest boundary. The inhabitants of these villages may graze, at the above privileged rates, 10 cattle for every 2 acres of land that had been cultivated on the average of the 5 years preceding the grazing settlement, which here was not simultaneous with Forest Settlement. The amount of the concession was settled once for all, and is not subject to annual revisions. The forest has to provide so much grazing, the Deputy Commissioner realises the dues from each village, and the tehsildars allot the individual shares with their usual impartiality. It is most difficult to verify the actual number of cattle in the forest, for the people have a rooted aversion to precise figures, and always manage so that the cattle are not at home, or otherwise spoil the count. The proper way to meet these tactics would be suspension of the concession. The fixed number, (5 head per average acre of cultivation) includes cattle kept for trade, as well as for agriculture, and extra cattle pay outside rates. Sufficient areas are set apart as grazing blocks. The area necessary turned out to be less than the amount of forest left out of the provisional Working Plan for the purpose, and this balance has accordingly been resumed, and brought under a separate Working

Plan for the present, but will eventually be included in the coppice or High Forest areas, according to position. Climbers are cut twice in the rotation, wherever most necessary, about 4,000 acres (4 coupes) a year, an interval of 12 years in mid-rotation being left without any climber cutting. This operation costs 10-12 pies per acre. The *coupe areas vary from 980 to 1,983 acres, according* to the stock on them. No planting or sowing is done. The fellings this year being about 1,900 acres will employ 2,000 men and 50 carts, but contractors are taking matters easy, so it is evident that much less labour would suffice. A curtain 50 feet broad is left round all *chāndas*, and along firelines: in this screen nothing is cut, as the marking begins by reserving everything in it. We measured the cover of two trees and found.

Girth 24 in. cover 12′ 9″ × 13′-9″ = 138 square feet, assumed as a circle.

Girth 40½ in. cover 16′ × 15′ = 188 square feet, assumed as a circle.

It was formerly proposed to put up grass roofs over a few young seedlings per acre, till they got out of reach of frost, but the proposal met with perhaps less consideration than it deserved, ploughing and sowing broadcast being preferred. This appears to me a mistake, for there are crowds of seedlings which perish just as the ploughed ones would. Further, the ploughing would probably run into something like Rs. 30 per acre in such grass. One tree per acre saved by means of a grass roof would cost perhaps 8 *annas, and would thenceforth begin to act as a centre of* infection for shelter that would be invaluable and almost immediate. There is a 50 foot fire line round the outer boundary where it adjoins private forests, and along roads. The grass is cut by 15th December, spread out to dry, and burnt by 15th January. The dense dry grass stands in the forest all the hot weather, till beaten down in the rains, but the firepath becomes green about March, so that there is little ground for apprehension so far as the *bonâ-fide* wayfarer and his pipe are concerned. There is little or none of that deliberate incendiarism which is *the characteristic of Bombay. The grass* lands outside forests are also burnt by the department without any objection being made.

January 7th. Rail to Sonaripur, 32 miles. Left Mailani by special train about 9 a.m., arriving about 2 p.m. Passed through No 1 of Marha Coppice, noting the re-growth At mile 11, a bank of about 20 feet high marks the bed of the Sarda river which is 13 miles wide, and has a corresponding bank at Dudwa, about mile 24. In this broad bed, the Sarda meanders about, continually eroding in uncertain places, and is very difficult to control, and even to cross on the march, being deep sand where dry, and frequently quicksand where wet. The principal of the railway bridges is built on piles where the water is shallow, and on 7 or 8 pontoons

where it is deep. The other bridges are all on sal piles which are driven by "monkey" pile-drivers 20 feet into the sand. The "monkey' is a heavy weight, hauled up to the top of a nearly vertical girder structure by means of a windlass, and then automatically released by the knocking out of a bolt, when it falls on the head of the pile. Two piles a day is average work, and more time is consumed in adjusting the pile, and the boat carrying the "monkey," than in the actual driving. The current, when we crossed, was about 3 miles an hour, and the deep channel about 15 feet of water. Spurs have sometimes to be built out up stream, to prevent the piles being washed out. There are two forest houses at Dudwa (called by the railway people Sohela.) At Sonaripur there is one, and also the depôt for B. G. sleepers, of which 1,50,000 have to come out this year. Work should begin 1st January, but is delayed this year by the unusual amount of water about the country.

January 8th. March to Changa nala, 7 miles, visiting on the road coupe No. 1 in Compartment No. 54 of Bhadi Working Circle The coupe area is 3,256 acres, in which an improvement felling was made in 1892-93, and the inferior species and unsaleable trees girdled in 1893-94. Total I class trees felled or girdled 7,700. A great fire passed over the whole area between here and Dudwa in 1895, and did great and widespread damage. The fire was very severe, killing many large trees, and large branches off many more, besides exterminating all young growth less than 10 years old. The last previous fire was some 20 years earlier. The first Working Plan was made in 1887, but was not based on sufficiently accurate data. In 1888, another Working Plan was prepared, which was also found to be incorrect. The actual Working Plan was prepared in 1892 by Babu Keshavanand. The whole trans-Sarda forests are divided into high and low alluvium. The former lies between the Soheli river on the south, and the Mohan (frontier of Nepal) on the north, and slopes from both sides towards the Juraha nala. in the centre. It is curious that the bed of the Juraha is some 5 feet or so below that of the Sarda into which it runs. The consequence is that the *chāndas*, or low open areas covered with strong grass, are several feet under water till the Sarda runs down about November. The average elevation is about 600 feet above sea level. The low alluvium is some 25-30 feet lower, and consists of both banks of the Soheli river the growth being principally grass with khair and miscellaneous jungle. On the high alluvium the soil is a sandy loam from 5 to 20 feet deep, mixed with variable beds of clay. A feature of the country to be reckoned with is an impervious bed of kankar, which sometimes comes too near the surface, and has beneath it frequently unfathomable sand, for the most part dry. The vegetable mould is about 3 feet deep. The average hot-weather water level is 15-20 feet below the surface. Frost is less to be feared than in Bhira forests on account of the

greater elevation. Sal forms $\frac{2}{3}$rds of the total stock, sain occurs chiefly along nalas and edges of *chandās*, also interspersed with sal over the whole area. Sain endures frost better than sal, yet the universal presence of sal seedlings, and the very general absence of sain in the *chandās*, appears to require more explanation than is found in the difference of seed.

The I and II Class trees in Bhadi Working Circle, 33,470 acres, were all counted, and it was found that of the I class sal, 50 per cent. were totally unsound, 43 per cent. partly sound (crooked, knotty, &c.,) and only 7 per cent. sound. Of the II class sal, 25 per cent. were quite unsound, 49 per cent. partly sound, and 26 per cent. sound. The past treatment had consisted in the removal of all good trees at a royalty of Re. 1 per tree by contractors under the Rajah of Khairigarh-Singhai, who obtained the land on agricultural grant, as already explained for Bhira. The remaining sal trees were tapped for resin, and still show the effects in their curiously thickened trunks. The land was then resumed by Government. The exploitable age was sought from sample plots at Dudwa, which gave the following rates of growth:—

Class	V	becomes	Class	IV	in 35	years.
„	IV	„	„	III	18·3	„
„	III	„	„	II	21·7	„
„	II	„	„	I	23·8	„

The age thus obtained is 99 years. The locality being very good, this was thought too short, so it was compared with sample plots in the Central Circle (Garhwal and Kumaon) These were of two kinds, thinned and unthinned. The former gave an average of 0·8 in. girth per year, the latter. 0·4 in. or an exploitable age of 90 and 180 years respectively, the mean being 135 years. The average time taken by a II Class tree to become I class was 33·75 years. It was therefore assumed that the average rate per annum would be 6in. girth, giving an exploitable age of 120 years, and a II class tree requiring 30 years to attain the I class. To get rid of unsound material as soon as possible, a felling rotation of 10 years was adopted. Then the possibility had to be fixed. Enumeration showed that the stock comprised 129,467 I class, and 291,440 II class sal. There were therefore of the II class trees exploitable each year $\frac{291,440}{30}$ or about 9,000 trees, which gives on the average $\frac{9,000}{33,470} = \cdot 3$ trees per acre per annum. Assuming the areas of the coupes to be equal, *i. e.* $\frac{1}{10}$th of the Working Circle: the exploitable stock at the end of the felling cycle will be: coupe 1, $9,000 \times \frac{1}{10}$ acre $\times$ 10 years; coupe 2, $\frac{9,000}{10} \times 9$;

coupe 3, $\frac{9000,}{10} \times 8$, &c. total $= 900\ (10+9\ +8\ldots+1) =$ 49,000, from which it is seen that there is a surplus stock of about 1,29,000—49,000 = 80,000 trees. (The figure 49,000 represents the number of II class trees attaining I class in 10 years). On account of the abnormal state of the crop it is proposed to remove the excess in 30 years, because its removal in 10 years would cause too great a clearance. The average number of I class sal that can be removed annually is, therefore, $9{,}000 + \frac{80{,}000}{30}$ or about 11,700 trees. Climber cutting and marking precede the felling by one year, and girdling follows the year after

The felling statement is as follows :—

Year	Area	Sound sal to cut	Unsound sal to cut	Total
1892-93	3,256	700	7,000	7,700
1893-94	2,792	600	7,500	8,100
1894-95	3,824	400	8,500	8,900
1895-96	2,983	800	11,000	11,800
1896-97	2,874	1,500	11,000	12,500
1897-98	3,991	2,500	10,000	12,500
1898-99	3,237	950	9,000	9,950
1899-1900	3,982	700	11,000	11,700
1900-01	3,258	2,050	12,000	14,050
1901-02	3,273	2,800	13,000	15,800

These figures are maxima, not to be exceeded. The coupes can only be considered immense, and their size is justified by transport considerations, as the railway is supposed, in principle, to run a branch line always convenient. Hitherto, the principle has not been much adhered to in practice, the lead from current fellings being 8 to 10 miles or more.

On this march we passed a monument to the memory of Mr. Abbey, a Coopers Hill officer who was killed by a dead tree falling on him. The stump is still there, nearly opposite the monument. Mr. Abbey was riding along the line, heard the tree crack, and spurred his horse, but the animal slipped and failed to get from under. Mr. Abbey's grave is in Lakhimpur, the monument here marks the actual site of the accident.

(To be continued.)

The effects of Fire on Grazing and the Production of Grass.

Forest officers in their endeavours to extend fire conservancy, constantly find the objection put forward that fire protection will interfere with grazing. There is among agricultural people a firmly rooted conviction, which is not confined to natives of this country, that burning off the dead grass that remains at the close of the autumn or in early spring, is a necessary condition for a good crop of grass. It is said that burning not only causes the grass to spring earlier and yield a more luxuriant crop, but, also destroys a vast number of ticks and other insects, which, if unchecked, would render grazing an impossibility.

On the other hand, it is asserted by Forest officers that the annual fires, though they may stimulate the grass to earlier growth, have the effect of killing out the better kinds and leaving only the coarser varieties which cannot be eaten by cattle except when they are quite young. That this is the case and that constant burning must necessarily cause deterioration of the soil, seems almost self-evident, but in the absence of recorded facts it is often difficult to convince people who hold opposite views. It is hoped therefore that those who are in a position to do so will take the matter up and give the readers of the "Indian Forester" an account of the precise effect on the grazing or grass supply, of any protective measures with which they have been concerned. I have heard it stated that in many cases where fire protection has been for many years the rule, the grass supply has been so obviously improved that neighbouring land-holders have come to recognize the value of such measures and have taken to fire-protecting their own forest lands, but I cannot find any reports in which such facts are officially recorded.

Another point in which information is desirable, is whether fire protection alone is sufficient to improve the crop in areas set apart for the production of grass, and if so, how many years it takes to obtain the desired results. So far, my own experience has been that where rank grasses have once thoroughly established themselves, protection alone, unaccompanied by heavy cutting or grazing, only causes such grasses to grow more luxuriantly and that the finer kinds do not re-assert themselves. This, of course, applies only to *bonâ-fide* grass lands: in areas under forest, the young trees which naturally come up as a rule kill out the tall grasses, but I have heard it stated that this is not the case in chir forests, in which fire protection is said to stimulate the production of coarser and ranker grasses.

X.

Note on a White Ant Preventive

In the Residency Gardens at Jodhpur, white ants get up the trees and have daily to be swept away. In 1896, Colonel H. B. Abbott, the then Resident, sent me a number of the Indian Agricultural Ledger, through the Judicial Secretary, pointing out a preventive measure suggested in it.

After taking Dr. George Watt's advice as to vernacular names, and the quality of the ingredients used (samples were sent to Dr. G. Watt) the preventive was prepared as follows—

English name.	*Vernacular name.*	*Quantity.*	*Value.*		
1 Dekamli gum (*Gardenia gummifera*)	Dekamli gund	1 seer	Rs.	1	0
2 Assafœtida	Hing	1½ seer	,,	1	9
3 Aloes	Musabbar	1 seer	,,	1	0
4 Vermilion	Sandhur	10 chs.	,,	0	4
5 Castor oil refuse	Khal Irind	1½ seer	,,	0	3
		Total cost	Rs.	4	0

All these ingredients but No. 4 were well ground together and kept in water for a fortnight. Then No. 4 was mixed in the fluid to the consistency of a thin paste and the compound was pasted on 60 trees of nim and shisham (girth 1 ft. to 2 ft.) from bottom to a height of 2 feet. Thenceforth, white ants did not come near the trees except when the paste was washed away by rain.

The preventive is so far successful, but its cost, it is to be regretted, is prohibitive.

JODHPUR,
29th January, 1898.

GOKAL DAS,
Forest Officer, Marwar.

Willow for Cricket Bats.

I am writing these few notes, as I do not know if other Forest Officers are aware of the large demand which is springing up for willow wood for cricket bats. The species in request is the weeping willow *Salix babylonica*, vern. Majnun. The common willow *Salix tetrasperma* vern. Laila is of much less value and only suitable for bats of inferior quality. The supply of *Salix babylonica* appears to be very limited, for traders have come from distances to obtain this species from Changa Manga, and say that they are unable to get it anywhere else.

I shall be interested to know if it occurs in large quantities in any other Divisions. The supply at Changa Manga has unfortunately been exhausted with the exception of a few trees reserved for yielding cuttings. Thousands of cuttings have been put in along watercourses from time to time since the plantation has been started; but only two or three hundred trees have survived to yield timber. It is very evident it was not known at the time the cuttings were put in, that the timber would turn out so valuable, or more care would have been taken with the cuttings and young trees. It was quite an accident that any survived. The trees felled were mostly rotten and were generally of a bad shape and covered with side branches. This is only natural, as the trees were only put in with the intention of strengthening the banks of the watercourses and they were only expected to yield fuel. It is now time, however, to give some attention to willow growing, since a demand has sprung up for its timber. The sound timber at Changa Manga fetched ten annas per cubic foot, equal to sound tún wood. Willow is very easy to propagate from cuttings in places where there is sufficient moisture, as along watercourses, streams, etc. I have just seen a very interesting book by Geo. G. Bussay & Co., London, called "The Bat of the Victorian Era." This gives a very interesting account of the manufacture of cricket bats: and besides, contains many useful facts about growing willow and the qualities of willow timber. It it quite a small book of 32 pages in large print, and full of good illustrations.

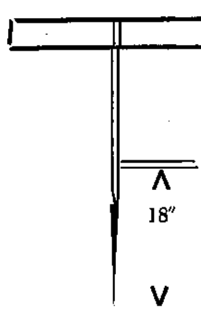
It appears that the sapwood is the valuable portion, thus the willow is an exception to most timbers, in which the heartwood is of the greatest value. The butt end yields very much superior timber to the higher portions of the trunk: hence the necessity for felling as low as possible.

The willow is propagated by cuttings which are technically called "sets." Each "set" should be 2 inches in diameter and 8 to 10 feet in length and as straight as possible. An interesting and important point to note is that "sets" should be taken from trees with "close" bark, in contradistinction to those with "open" bark A little experience is required to distinguish the two: illustrations of the two different barks are given in Bussey's book. The "close" bark trees yield the best driving timber.

The "sets" should be clean cut obliquely by a blow from a sharp knife or axe, and it is best to cut against a wooden mallet or other block of wood. The reason for cutting obliquely is to enable the soil to be pressed more closely around the cut surface. They should be put out in rows about 12 ft. apart along the sides of streams or watercourses. A good plan is to plant them in a meadow, and then transplant after 2 or 3

years. The cut should be made just below a bud. It is advisable to put the "sets" in the ground in a slanting position. This, together with the oblique cut, enables the soil to be pressed tightly round the cut surface. If put in vertically, the soil may lie loosely round the cut surface, and the "set" is liable to wither. Leaves should be removed from a "set" to stop excessive transpiration.

Holes should be made for the "sets" with a planting iron, which can easily be made from a bar of old iron. It should be pointed at the end, and it is well to have a piece at right angles at about 18 inches from the point, so that the foot can assist if necessary in pushing it into the ground. A bar of wood at the top will make a handle.



The willow being a very soft timber is liable to many ills and requires a little looking after. Damage to its bark is very common, and I have seen considerable damage done to it by porcupines. The trees should be kept well pruned of side branches to produce timber free from knots.

Felling is done when a girth of about 45 inches has been attained; but there is a demand for smaller timber also. The age for felling will probably be from 20 to 30 years. They must be watched, however, as decay sets in very early. Felling should be done in the winter when the sap is down. For cricket bats, lengths of 2 feet 6 inches are required.

There is no doubt that the game of cricket is spreading rapidly in this country, and there is every reason to suppose that efforts made to grow good willow timber now, will be well repaid in the future.

B. U. C.

9th January, 1898.

III.—OFFICIAL PAPERS & INTELLIGENCE.

Note on the Fructification of Deodar.*

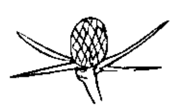
I have made during the last 12 months a most careful study of the fructification of Deodar at Simla, which may interest you. Both male and female flowers appear first with light brown covering sheaths like this. (fig 1)

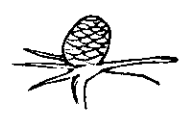
The covering sheath opened in 1897, as regards the male flowers, from the 25th July, and in a very few days the majority of male flowers appeared. However, there were some late individuals, and some only came out in the end of August. The first female flower I observed naked was on the 1st of September. There is no difficulty in recognizing the female even in the early stages of growth, and in fact with a magnifying glass its characteristics can be ascertained when still enveloped by its sheaths. In the male flowers the scales are closed up from the very beginning like this. (fig 2)

In the female flower they are gaping like this. (fig 3) There is very little difference in the general shape at the outset, which can be seen by comparing the female with a late appearing male; but, of course, when the female appears, the majority of males have already assumed an elongated shape. When the pollen is shed, the females are moist and the pollen sticks to them.

As soon as they are fructified, the scales of the female close, I believe on the very first day, but this I mean to further examine.


No. 1


No. 2


No. 3


Male (enlarged).


Female (enlarged).

* NOTE.—This was sent to our predecessor last Autumn ⊗ and as the subject is one of great interest to all Forest officers in the North-West Himalaya, we think it right to publish it, and invite investigation. It is an extract of a letter from the Inspector-General of Forests, to Sir D. Brandis.

HON. ED.

⊗ and published on p 411 of Vol XXIII

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Then they seem to assume a little rounder appearance for a fortnight or so, and then the growth seems to stop till the following March, or is at least imperceptible. From March to end of August they increase in size and then the ripening time begins. In the majority of cases males and females are on separate trees, but they are also found on the same tree, where as a rule the females occupy the lower, the males the upper branches. I have never observed males and females on the same branch. As regards this I have been contradicted, but people did so from memory only and as yet I have had no proof that my observation is incorrect.

B. RIBBENTROP.

Reproduction of Teak by means of Taungyas.

Letter from the Inspector-General of Forests, to the Revenue Secretary to the Government of Burma.

Dated 1st July, 1897.

SIR,

With reference to your letter of the 21st May last, I beg to thank His Honour the Lieutenant-Governor for having given me an opportunity to express my opinion as regards the reproduction of teak by means of *taungyas*.

2. The Government of India in their review of the Burma Annual Reports for 1895-96 and Lieutenant-Governor's resolution thereon state :—

"It is unquestionable that the reproduction of teak and the other more valuable trees must in the great majority of cases be promoted by means of protection and improvement fellings, since larger areas can be treated in this manner than in any other. There are, however, many tracts in which the valuable species are represented very sparsely or not at all, and in these, improvement fellings and the most careful protection would be of no use. In such localities, if they are otherwise suitable for the growth of teak, the tree must be artificially introduced, and in this respect the teak *taungyas* have proved of great benefit. That such artificial plantations, which it is hoped will in time form centres for the natural spread of the tree, will require attention during the earlier stages of existence, has always been anticipated. If such plantations are in some cases overweeded and not thinned out in time, this is an error in practice and not in principle. There is no doubt, however, that teak *taungyas* should be established only in localities where the reproduction of the tree cannot be effected by simpler means. There should apparently be no difficulty in providing other work for the *taungya* cutters in reserves which have been planted out, especially as they have their own *taungya* areas upon which to fall back for their crops."

3. You will observe that the opinion there expressed, in which I share, coincides with that of Messrs. Nisbet and Dickinson, though it does not enter into the same degree of detail.

There can be no doubt that the formation of extensive forests of one kind of tree is always accompanied by certain dangers, especially where this has been attempted in localities in any way unsuitable to the species. However, our teak *taungyas* do not aim at the establishment of large uninterrupted areas of teak plantations, but of plots of more or less extent interspersed in forests of a mixed character and in localities situated within the natural teak zone, where for some reason or other unconnected with the suitability of soil or locality, the teak has disappeared or has not properly established itself.

4. Mr. Corbett states in his note, that the object of teak plantations seems to be to induce the species to grow in places where it was not represented before and where, in the hundreds of years that have passed, it would surely have forced its way and found a footing if the soil and other conditions had been suitable to it. This is not so, or, at least, but partially. The object of teak *taungyas* is not to introduce the tree on unsuitable soil, or in places where the drainage is bad, or where other physical conditions pertaining to the locality prevent the healthy growth of teak; but to introduce it on suitable areas, where, owing to the growth of gregariously-flowering bamboos and severe fires during the period immediately following their seeding, the tree has had no chance of establishing itself and but a meagre one of reproducing itself.

To the west of the Arakan Yoma hundreds and hundreds of square miles of pure bamboo forests are to be found, with only a tree here and there, or often with no trees at all, and during hundreds of years, to use Mr. Corbett's words, none have found a footing. There are many other localities like this in tropical climates. Surely Mr. Corbett does not intend to argue that all these areas are physically unfit for arbori-vegetation, and that by judicious interference with existing conditions they could not be made to bear tree-forests?

5. The system of teak *taungyas* was invented and elaborated mainly in order to ensure the reproduction of the tree in localities where the gregariously-flowering bamboos, which I fully recognise to be one of the greatest enemies of the teak, held possession of the ground. I do not, under these circumstances, understand Mr. Thompson's remark, recorded in paragraph 14 of the Tenasserim report, that persistence in such operations will probably greatly favour the growth of bamboos. If, owing to want of care, we permit the bamboos to re-establish themselves as masters of the ground, we are only where we were previous to our attempts to make trees of good species take

their place. We have failed to subordinate the bamboo, which in most cases, I maintain, is due to our own want of care, and this cannot be urged as a fault of the arbori-*taungya* system.

Both Mr. Thompson and Mr. Prevost's observations recorded in paragraphs 14 to 18 were made in the Tenasserim Circle. Whether the *taungyas* visited by those officers were established in suitable localities, I do not know, and have no means of ascertaining; but the records I have seen from time to time show that the earlier operations were comparative failures from the very outset, that many of them were burned on more than one occasion, and that they hardly ever received that care and supervision which sylvicultural operations of whatever kind required. It seems a pity that Mr. Prevost should have, under these circumstances, expressed that unqualified disapproval of pure teak plantations as carried out under the *taungya* system, which, under certain circumstances, is the only practical *method* of ensuring a continuous reproduction of the tree; but I am not opposed to such questions, though highly controversial, finding a place in annual reports, as their detailed consideration is thereby ensured, which in this present instance is particularly desirable.

There is no doubt that, with the splendid early growth of the teak in the Tharrawaddy *taungyas* before us, we believed that much less after-interference would be necessary in order to establish plots with a greatly preponderating mixture of teak than was subsequently found indispensable. When this was first ascertained, we naturally fell into mistakes in the opposite direction, and the weedings may have been perhaps too drastic and perhaps ill timed, exposing the soil too much to the direct action of the rain; but it must not be forgotten that we have to deal with a vegetation difficult of control and with labour difficult to guide, and that to do this we have but a small trained establishment. Undoubtedly mistakes have been made in the treatment of some *ɀas*, even in Tharrawaddy, and the success is in these cases not what we *had hoped for in the early days nor what it might have* been; but, as pointed out by Mr. Dickinson, there is hardly a *ya* that does not contain enough young teak to greatly improve the future stock.

7. Since the day when *taungya* plantations were first started, the Burma forester has gained in experience, a better trained subordinate staff has been organized, and better supervision is gradually becoming available; and we may, therefore, now count on more general success than has been obtained in the past in establishing a satisfactory young growth by means of such plantations, and on forming the forest of the future in the areas dealt with, by means of fire-protection and judicious treatment. The immediate questions connected with such treatment are :—

(a) How long and to what extent weeding should proceed? In my opinion the early weeding cannot be too severe so long as the weeds are not pulled up by the roots during the rains, which may cause the washing away of the soil.

(b) To what extent are cleanings to be carried out in the years following? In this respect I agree with Mr. Corbett that nothing should be cut that does not overtop the teak or interfere with the full development of their upper leaves.

(c) When should thinnings begin and what should be the degree of such thinnings? This depends entirely on local circumstances and requires to be decided on the spot. I am in favour of fairly early thinnings, to be followed by pretty severe thinnings as soon as the teak is out of danger of being over-topped, in order to encourage the development of a good crown of foliage; and believe that all thinnings should be accompanied by the removal of all soft wood and fast growing species of other kinds. Thinnings have, till quite lately, been greatly neglected.

8. I believe it to be a fact that of late years teak *taungyas* have sometimes been established in localites where they were not required and where reproduction could have been ensured by means of fire-protection and improvement fellings; but this again is not a fault of the principle, but merely of of its application.

Primâ facie, the establishment of teak *taungyas* should be restricted to areas more or less under the influence of dense shading gregariously-flowering bamboos. I know, however, a good many localities, some even in Upper Burma, in the Sinkan Valley for instance, where teak has practically been exterminated over considerable areas, and in such, I would consider the establishment of teak *taungyas* eminently advisable and much less troublesome as regards their future treatment than in the dense bamboo forests of Lower Burma. They would form groups, from which the tree would spread naturally in years to come.

9. In my opinion it would certainly be inadvisable to put a stop to the future extension of teak *taungyas*, and difficult to lay down general orders and rules limiting their future establishment. The question depends so completely on local conditions that it must be left entirely to the observations made and conclusions drawn by local officers.

It seems almost superfluous to say that teak *taungyas* should not be attempted where the soil and other physical conditions are unsuitable to the trees, nor that their establish-

ment is necessary where natural regeneration of teak, pyinkado and other valuable species exists, or where it can be obtained by improvement fellings. Such fellings, however, as pointed out by Mr. Dickinson, will not do much to increase the quantity of teak in localities where the forest contains little or no teak already, or (I beg to add) where, though some seed-bearers may exist, dense bamboo cover prevents all possibility of regeneration, except at long intervals during the time of flowering. To such localities should teak *taungyas* be restricted.

VI.—EXTRACTS NOTES AND QUERIES.

The Colouring Matters of Various Tanning Materails.

In continuation of his researches on the colouring matters of commercial tanning materials (IMP. INST. JOUR., Vol. III, p. 309), Mr. A G. Perkin, F. R. S. E., contributes to the October number of the *Journal of the Chemical Society*, a paper dealing with several of the well-known products used in the leather industries.

CAPE SUMACH.—This material consists of the leaves of the plant *Colpoon compressum*. It contains, according to an examiintion made in the Leather Industries Laboratory of the Yorkshire College, about 23 per cent. of a catechol-tannin, having the usual characters of these bodies. When used for tanning, it produces a leather having a slightly yellow tinge.

Mr. Perkin finds that this dyeing property is due to the presence of a glucoside of the yellow mordant coloring matter "*quercetin*." The glucoside was found to have a composition represented by the formula C_{27} H_{30} O_{17}, and to be resolved on hydrolysis into *quercetin* and the sugar dextrose. For this new quercetin glucoside the name "*Osyritrin*" is proposed. The tannin of Cape Sumach was not carefully examined, but it was found to be a tannin-glucoside giving on fusion with potash the well-known substance protocatechuic acid, and on hydrolysis an anhydride and a sugar. In these particulars it closely resembles quinotannin and quinovatannin.

CATECHU.—Two varieties of this material are known in commerce (*vide* IMP. INST. JOUR. Vol. III., p. 88). Both, viz., "*white*" and "*black*" catechu, have been examined by Mr. Perkin. In the case of the former, the observation of Lowe (*Analyt. Chem*, 1874, 12, 127), that it contains *quercetin* is confirmed. With regard to "black" catechu, 400 grammes yielded only 0.05 gramme of a yellow colouring matter, which, however, was found to agree in the melting point of its acetyl derivative and in its tinctorial properties with *quercetin*.

RHUS COTINUS.—As in the case of *Rhus coriaria* (IMP. INST. JOURN., Vol. III, p. 309) this material, commercially known as "Venetian Sumach," was found to contain, not "quercetin," as Lowe concluded but "*myricetin*" giving an acetyl derivative melting at 203°-204° C. (acetyl quercetin melts at 191° C.) Mr. Perkin, however, points out that the existence of "myricetin" in Venetian sumach must not yet be considered absolutely proved, as the material is very liable to extensive adulteration.

It must be noted that the tanning matters considered above are all either leaves of plants or extracts of these. In addition to this class of bodies, there exists a class of tanning materials consisting mainly of seeds and fruits of plants. The most important of these are given in the following table :—

Commercial Name.	Botanical Source.
"Valonia"	*Quercus Ægilops*
"Divi-divi"	*Cæsalpinia coriaria.*
"Myrabolans"	*Terminalia Chebula.*
"Agarobilla"	*Cæsalpinia brevifola.*
Pomegranate rind	*Punica Granatum.*
Gall nuts	*Quercus infectoria.*

Chemical investigation of all these substances showed clearly that they contained no dyestuffs of the "Quercetin" or allied groups. As they are all known to contain either ellagic acid or ellagitannin, it appeared probable that it was to this constituent that their tinctorial property should be ascribed. A series of dyeing experiments, the results of which are concisely exhibited in the

accompanying table. showed that this was so, the shades obtained being almost identical with those obtained from pure ellegic acid.

Name of Dyestuff.	Chromium mordant.	Aluminium mordant.	Tin mordant.	Iron mordant.
Ellegic acid ...	Pale green olive yellow.	Pale olive yellow.	Scarcely dyed	Somewhat olive, grey-black.
Valonia nuts ...	Green olive yellow	Faint olive	Scarcely dyed	Weak grey-black.
Pomegranate bark	Yellow olive ...	Faint olive	Scarcely dyed	Weak bluish grey-black.
Gall nuts ...	Green olive ...	Faint olive	Scarcely dyed	Purplish black.

A point of considerable theoretical interest, and possibly of ultimate practical importance, is the similarity of the decomposition products of the contained tannins with those of the colouring constituents of the same plant. The following table shows this in a convenient form :—

Tanning material.	Tannin contained.	Decomposition products of the Tannin.	Colouring matter.	Decomposition products of the colouring matter.
Quebracho colorado	Quebracho tannin	Phloroglucinol and Protocatechuic acid	Fisetin ...	Resorcinol. Protocatechuic acid.
Rhus species	Gallotannin	Gallic acid	Myricetin	Phloroglucin. Gallic acid.
Catechus	Catechin	Phloroglucinol and Protocatechuic acid ...	Quercetin	Phloroglucinol Protocatechuic acid.
Cape Sumach	A catechol-tannin	Protocatechuic acid ...	Quercetin	Phloroglucinol and Protocatechuic acid.
Divi-divi	Ellagitannin	—	Ellagacicid	—

Chenab Canal Forest Policy.

Government awaits the result of the deliberations of the Financial Commissioner, Chief Engineer, Irrigation Department, and Conservator of Forests as to the forest policy to be adopted in the case of the Chenab Canal. The question at issue is whether the plan of a large irrigated plantation in a central situation at Lyallpur, as was at first proposed, is to be abandoned in favour of a series of belt plantations along the

banks of the canal and its distributaries as has been recommended by the Inspector-General of Irrigation. No doubt as between putting the land under crops or under trees, it would be difficult to show the latter course to be the more profitable; in fact, a recent examination of the question as regards Changa Manga showed that Government gets a return from that plantation equal about to what it would receive in land revenue, if the area were cultivated, without anything being left for interest on capital or rent of the lands; but the utility of Changa Manga or of any similar large Government plantation, must not be measured entirely by direct financial results. The existence of such large fuel supplies is a gain to the general public, no less than to the Railway Administration in keeping down the price of fuel.—(*Indian Engineering.*)

A Log Drive in the Alleghanies.

TERRIBLE EXPERIENCE.

In these days of modern appliances and perfected means of travel by steam and electricity, mutilating distance at the rate of a mile a minute or even more, is considered nothing so startling, but the rapid transit and the *modus operandi* thereof participated in by John Sweetwood, a lumberman in the wilds of the Alleghany Mountains, one day recently, corners the market on fast travelling. Sweetwood, says a writer in the *Philadelphia Times*, is a young man about 22 years of age. He is the son of a farmer from one of the most rural districts of the United States, big, raw-boned, and fearless of anything on top of earth. As with all farmers, so with this one; work during the winter season is slack, and John, thinking to earn an extra penny for himself, determined late in the fall of 1896, and with the opening of the lumbering season, to go into the woods and spend the winter "logging." In lumbering, as in every other kind of employment, experience counts for a great deal, and the inexperienced, or "greenies" as they are termed in the lumberman's camp, are not deemed capable of performing the work of an old hand at the business, and so are generally put at work on something more simple. Fifteen and twenty years ago lumbering was vastly different in the Alleghanies from what it is to-day. Then virgin forests covered the entire range of mountains and the lumbermen had only to select the timber nearest to some stream, and the work of geting the logs to water to float down to market was a question of minor importance. Now, owing to the fact that all the

timber along the large streams has been cut, the getting of the logs to water is one of the gravest questions confronting the lumberman. Where practical, what are termed "log drives" are erected for this purpose. A "log drive" is simply constructed by laying two hewed logs alongside each other, in a trail out from the camp to the nearest stream, sometimes five, eight, or ten miles away. These drives are usually prepared early in the fall, and when the first fall of snow comes they are put in condition for use by hauling a drag along between them, which packs down the snow. On this water is poured and allowed to freeze, the result being a rude trough of ice, over which the logs glide down grade with startling swiftness. But these drives are not all down grade. Perhaps half the distances will be up grade, and to get the logs up the mountain, teams of horses are used. After the logs are rolled into the drive, a team is hitched to a log with perhaps 100 ahead of it, according to the steepness of the incline, and in this way the whole string is pushed to the top. It was while working on one of these drives that Sweetwood met with the following thrilling experience:

TERRIFIC SPEED.

With a canthook he was to follow the first log as a sort of steerer, whose duty it was to see that all was well. If the log caught fast on any protruding ice, snow, or wood, with his hook he would loosen it so that the trail would come in. When the drive is in bad condition, the steerer always finds plenty to do to keep him busy, but if there is lots of snow and cold whather, the slide is usually all that can be desired, and the steerer invariably has only the monotony of tramping alongside and watching the logs glide along. This was the case during the late cold weather, and Sweetwood, evidently tired with so much tramping, determined to use the logs as a means of more easily getting up the mountain. With the driver of the team away back out of sight, Sweetwood climbed on the foremost log and congratulated himself how much nicer it was than trudging along in the snow. In this pleasant mood he either forgot that when the logs reached the top of the incline and began to descend the grade, their transit suddenly increased, or else he was so absorbed in the pleasures of his ride that he forgot where he was. Be that as it may, however, when the first log went over the incline and began going down, Sweetwood was still on it, and before he could dismount the log was going at such a speed that to even try to get off meant death. In this dilemma all that could be done was to hold on like grim death and await the worst, which to all intents seemed death in some form or other, and most likely a most horrible death. Talk of express trains, electricity, or rapid

transit in any of its various forms, they are not in it with the way that log trail went down the mountain side. From the summit to the west branch of the Susquehanna, where the drive ended, was at least six miles, and in most places the drive was quite steep. Gathering momentum with every foot of its descent, the log with Sweetwood on it sped on as if shot from some great gun. Trees and rocks were passed with such startling rapidity that they seemed as one solid blurred wall: the snow was only a glare of white, the log drive itself seemed a diminutive line, only faintly discernible, winding in and out like a huge snake. Sweetwood early in the ride lost his hat, and his hair streamed out behind like the tail of a bob-tail horse; the wind sang deafening tunes in his ears and almost blinded him with its velocity, while the frost in the air seemed like hail pellets striking him in the face. There was little time for thought, but even in the few seconds there was, Sweetwood wondered what the end would be.

Sensational Plunge.

Fortunately for Sweetwood, and the only reason that he is alive to relate his experience, the log on which he was perched was a large, smooth one, and glided along comparatively easy with little turning, and never once snagging on any protruding substance. Down, down went log and rider, and in *less time than it takes to tell it, the glimmering expanse of the* Susquehanna burst into view. Although nearly unconscious, Sweetwood remembers giving one hasty glance towards the river and noted the fact that it was comparatively clear of logs at that point, and the next thing he knew he was plunged into about eight feet of water. Contrary to his expectation of being crushed to death, he was unhurt, save the sickening sensation of the thrilling ride and the shock sustained by his sudden plunge into the river. When he struck the water he was still on top of the log and went under with it, but when he arose to *the surface he was alone and within a few yards* of the opposite shore. With some little difficulty he pulled himself out of the water, and after recovering to some extent the use of his faculties, viewed with wonderment the scene of his ride, and shudderingly thought of his narrow escape. In his descent he supposed the entire trail of 100 logs was following swiftly after the one he was on, and when plunged into the river he expected to be ground to pieces with the logs. Now, as he stood on the bank of the stream and looked, not another log was in sight, and his wonderment increased. Gathering *himself together as well as possible,* he sought a sheltered spot, and with dry matches found in an inside pocket, kindled a fire and dried himself and sought composure after his thrilling experience. Several hours later he made

his way downstream until he found a place to cross, then retraced his steps to the drive and started back to camp. About half-way up the mountain he found an explanation of the missing logs. The log next to the one on which he had been perched had evidently snagged on something in the drive, and its sudden stop had tumbled the whole string of 99 in one promiscuous heap on the mountain side, breaking the drive and tearing up small trees by the root.—(*Globe.*)

Retirement of Mr. S. H, Collins.

We take from the *Pioneer* the following extract :—

"*We understand that Mr. Collins, Agricultural Chemist to* 'the Government of India, has, owing to failing health, resigned 'his appointment, having given the required six months' notice, 'which expires in April next. Originally, Dr. Leather was 'Agricultural Chemist to Government on a salary of Rs 1,250 'rising to Rs. 1,500 per mensem ; and Mr. Collins was 'Assistant Agricultural Chemist on Rs. 700 to Rs. 900 a 'month ; but a short time ago, when Dr. Leather's five years' 'term of office expired, his agreement was not renewed, as 'Government desired to reduce this establishment. Mr. Collins 'then became Agricultural Chemist ; but with his resigna- 'tion the appointment will again fall vacant."

Many of our readers will be sorry to read this, for Mr. Collins has been so useful to us at Dehra Dún in the analysis of forest products and in teaching work, that we shall miss him a good deal. We can only wish him the success at home which, had his health remained good, he would probably have attained in India.

THE

INDIAN FORESTER.

Vol. XXIV.] March, 1898. [No. 3.

Note on the Forest School Tour in Oudh—No 2.

By F. Gleadow.

January 10th. Visited current Improvement Felling in Coupe No. 6, Compartment No. 65. *Area 3,991 acres.*—In this coupe not more than 2,500 sound and 10,000 unsound sal of class I may be cut. The trees were marked last cold season. Tenders from contractors are received in September and the coupe is divided into sub-coupes accordingly. Two contractors cannot be allowed to cut in one sub-coupe at the same time, so if one man wants logs and another sleepers, each works in a different sub-coupe, and when each has cleared his sub-coupe of all suitable material, and has not filled his indent they exchange, or each goes to another sub-coupe, leaving the first open to a man who wants only scantlings, &c.

Next year all marked, but unsaleable material, good or bad, not taken by contractors, is girdled departmentally. The only saleable species are sal and sain, called here "asaina" or "asna" all other marked trees being girdled, but inferior species are not marked if useful for sylvicultural reasons. Sal fetches 6 As. to Re. 1-2-0, and sain 4 As. to 10 As. per cubic foot, according to size. The wood is thus practically extracted on a permit system limited by previous marking. We measured a number of trees as follows:—

No.	Species	Girth	Height	Cover	=	as circle sq. ft.
	Sal	in.	ft.	ft.		
1	"	9	"	2 by 3	=	5
2	"	28	"	12 by 9½	=	91
3	"	29	"	16¾ by 14½	=	192
4	"	31	"	22 by 17	=	298
5	"	32	"	7 by 16¼	=	106
6	"	36	"	13 by 16¼	=	168
7	"	36	"	17 by 19	=	254
8	"	37	"	26½ by 15	=	338

No.	Species	Girth in.	Height ft.	Cover ft.	=	as circle sq. ft.	
9	Sal	38		16½ by 11¾	=	156	
10	„	39	85	15 by 17½	=	207	
11	„	39		17 by 24	=	330	
12	„	42		31 by 20¾	=	526	
13	„	42		24 by 15½	=	306	
14	„	43		27 by 29½	=	627	
15	„	43	84	29 by 27	=	616	
16	„	44		17 by 24	=	330	
17	„	48		24 by 24	=	452	
18	„	48		35 by 23	=	660	
19	„	48		28 by 29½	=	649	
20	„	49		22 by 23	=	398	
21	„	52		26 by 27	=	552	
22	„	54		22 by 21¾	=	376	
23	„	60	100	32½ by 25		650	
24	„	60		24 by 30	=	572	
25	„	60		25 by 24¾	=	486	
26	„	60		28 by 31	=	683	
27	„	61	100	18½ by 28	=	424	
28	„	62	100				
29	„	64		25 by 35	=	707	*(semi isolated, and thickened through tapping.)
30	Sain	66	90				
31	Sal	132	90	56½ by 38½	=	*1772	

In order to see that material is fully utilised, a "*That Mohurrir*" is employed by Government but paid by contractor. "*That Mohurrir*" means gang clerk, one such man being attached to each gang of 8 saws and 16 sawyers. His duty is to number each log, count the produce, and see that all the sleepers possible are cut out of a given piece, no good timber logs cut up, &c. The Forms *kept by the* That *Mohurrir form the basis* from which the prescribed Range and Divisional Forms are made up. The forms and instructions are as follows.

ORDERS FOR THAT MOHURRIRS.

"(1) When That Mohurrirs are appointed to look after 'felling of logs, the following orders are to be carried out.

'(*a*) Every first class sound log in the area given to the 'contractor must be numbered by serial number, whether it be 'cut by the contractor or not, when the tree is not cut, a remark 'should be given why it was not cut.

'(*b*) The uncut trees are to be marked on the place where 'the Improvement felling mark has been put on.

'(*c*) The cut trees are to be marked on the stumps as 'well as on the log.

'(*d*) A register on plain paper is to be kept of all the numbered trees; giving reasons for trees not being felled.

'(*e*) The felled trees will be entered as usual in Range 'forms I and II.

'(*f*) In order to arrange the logs in classes, every log which 'measures 4 ft. or more at butt end is to be I class; 3 ft. to '4 ft. II class; 2 ft. to 3 ft. III class; under 2 ft. IV class.

'(*g*) In form I, only the logs felled will be entered daily 'according to species and class.

'(*h*) In form II, the cubic contents will be entered of the 'felled logs only daily, the column headed No. of working circle 'being cut out and date and month put in its place. The following 'are samples of the forms to be kept.' (I)

THAT MOHARRIR'S FORM FOR FELLING OF I CLASS SOUND TREES.

Date and Month.	Number.	I Class.		II Class.		C ft.	Remarks.
		Length.	Girth at centre.	Length.	Girth at centre.		
December 1st	1	30	48	...	...	30	
	(2)	...	60	...	...	...	Not felled because found hollow.
	3	...	...	32	36	27	
,, 2nd	4	30	48	...	...	30	
	5	30	48	...	...	30	
	(6)	...	54	...	...	..	do. do.
,, 3rd	7	30	54	...	...	30	
	8	30	54	...	...	30	
	9	...	...	32	36	27	
,, 4th	(10)	...	60	...	...	...	do. de.
,, 5th	11	...	...	32	36	27	
,, 6th	12	40	60	...	...	...	Felled but found hollow.
	13	35	54	...	...	...	do. do,
	14	30	48	...	..	30	
,, 7th	15	30	48	...	...	30	
	...	...	...	...	...	..	Signature of That Mohurrir.

RANGE FORM NO. I.

Month and date.	Sal.				Assaina.				Mis:				REMARKS.
	I	II.	III.	IV.	I.	II.	III.	IV.	I.	II.	III.	IV.	
1st	1	1	...	...	...	...	...	...	...	...	...	...	1 I class tree not felled.
2nd	1	...	...	...	1	...	...	...	...	...	...	...	1 do. do.
3rd	2	1	...	...	...	...	...	...	...	...	...	...	
4th	...	...	...	...	...	...	...	...	...	...	...	...	1 do. do.
5th	...	1	...	...	...	...	...	...	...	...	...	...	
6th	3	...	...	...	...	...	...	...	...	...	...	...	
7th	1	...	...	...	...	...	...	...	...	...	...	...	
Total	8	3	...	...	1	...	...	...	...	...	...	...	3 do. do.

RANGE FORM NO. II.

No. of Working Circle.

Date and Month.	No of Comptt.	Name of Contractor.	Sal.			Assaina.			Mis.			REMARKS.
			Logs.	Bullies.	Scantlings.	Logs.	Bulli.	Scantlings.	Logs.	Bullies.	Scantlings.	
1st December	57	Habibul-lah	57	...	...	...	...	...	...	...	...	
2nd ,,	...	,,	30	...	...	30	...	...	...	...	...	
3rd ,,	...	,,	87	...	...	...	...	...	...	...	...	
4th ,,	...	,,	20	...	...	...	...	...	...	...	...	
5th ,,	...	,,	30	...	...	...	...		...	...	...	
6th ,,	...	,,	30	...	...	...	...	...	...	...	...	
Total	...	,,	261	...	...	...	...	...	...	...	...	

Copies of Forms I and II will be sent weekly to the Range Officer. Copy of That Moharrir's Form for felling 1st class logs, will be sent weekly through the Range Officer to the Divisional Officer.

(2). When That Moharrirs are appointed to check sawing operations, they will number serially the trees as they are felled on the stumps.

(a). The following register will be kept up showing the outturn from each tree.

THAT MOHARRIR'S FORM FOR SAWING OPERATIONS.

Name of Contractor. *Number of Compartment*
Sal

Date and Month.	Serial No. of tree and class. I.	II.	Depth and girth. 5" × 4" No.	Length in feet.	Cubic Contents.	4" × 4" No.	Length in feet.	Cubic Contents.	4" × 3" No.	Length in feet.	Cubic Contents.	1²" × 12" No.	Length in feet.	Cubic Contents.	REMARKS.
December 1st ...	1	..	8	15	16-10-0	{ 20	15	33-4-0							
,,	2	...	...	...	...	2	16	3-6-8							
,, ...	3	...	...	...	...	...	...	...	...	...	...	2	24	48-0-0	
,, 2nd ...	4	...	8	17	19-1-4										
,, 3rd ...	5	...	...	...	...	...	...	...	...	...	...	1	24	24-0-0	
,, ...	...	6	8	13	14-7-4										
,, 4th ...	...	7	6	13	10-11-6										
,, 5th ...	8	...	...	...	...	...	...	...	...	...	...	1	24	24-C-0	
,, 6th ...	9	...	...	..	...	...	...	...	12	14	14-3-0				Turned out too hollow to saw
,, 7th ...	...	10	...	...	...	...	...	...	...	...	...	..	...	...	Do.
,, ,, ...	11	...	...	...	...	...	...	...	...	...	...	...	...	..	Do.
															Signature of That Moharrir.

"NOTE.—The serial number of tree is to be entered under 'the class, a separate sheet being kept for sal and asna.

'In the heading, the depth and width are only to be writ- 'ten, the length is to be entered under column heading 'length in 'feet.'

'*e. g.* From tree No. I Sal which is first class, 8 scantlings '15 ft. by 5 in. by 4 in. were cut and 4 pharras remained.

'From tree No. 2, 20 scantlings 15 ft. by 4 in. by 4 in. and '2, 16 ft. by 4 in. by 4 in. were cut and 6 pharras remained over.

'From tree No. 6, 7 scantlings 13 by 5 by 4 and 4 pharras 'were cut, this tree being II class.

'From No. 10 nothing was cut as it turned out hollow.

'The cubic contents of pharras (slabs) are not to be entered. 'In order to arrange the trees in classes, every tree which '*measures 4 ft. or more at butt end is to be I class, 3 ft. to 4 ft.* 'II class, 2 ft. to 3 ft. III class, under 2 ft. IV class.

'Copy of That Mohurrir's sawing form to be sent weekly by 'mohurrirs to the Divisional Office through Range Officers ; copies 'of Range Forms I and II to be sent weekly to Range Officers."

January 11th.—Visited markings for improvement felling in No. 5,—3,237 acres, in which only 9,950 I class trees are to be cut next year. The crop is very open already and the young growth quite insufficient, consisting in some places of nothing but small seedlings buried in grass, in others of small poles mostly distorted by grazing or overhead cover. The part visited contains very few young trees likely to make good timber, and the already existing grass constitutes a danger of the utmost gravity, as seen by the results of the disastrous fire of two years ago. Fire protection is good here, but the best of protection is uncertain safety if there is much grass. Any felling here at all needs an excuse, and that is found in the fact that many of the old trees are extremely rotten, while in some cases they are injuring seedlings large enough to need uncovering.

January 12th.—Returned to Sonaripur, after going out in the morning, laying out a sample plot of 2 acres, and measuring part of the crop. The object is to compare the rate of growth in thinned and unthinned areas. A fellow plot will be laid out on the other side of the road in this year's fellings as soon as they are finished. Found on arrival that the trains were not running owing to the defect in the bridge at Dudwa. There is no Telegraph nearer than Mailani, to which place a telegram had yesterday been sent by hand for Bareilly. A reply had been hoped for, but none came.

January 13th.—Waiting at Sonaripur. A train might appear at any time without warning, but did not do so. This will interfere with the Punjab tour.

January 14th.—Marched to Dudwa, or Sohela. 7 miles, intending to march in to Mailani if necessary, but there were

hopeful rumours that a train would run to-morrow, and a reply to my telegram also appeared promising, but no train came.

January 15th.—Loaded up camp ready to march if no train arrived, but it came in about 10 A. M. and went on to Sonaripur Depôt, returning about 2 p. m. to take us on to Mailani where we caught the 4·30 train for Bareilly.

II.—OFFICIAL PAPERS & INTELLIGENCE.

Mechanical Tests of Pyinma Wood.

REPORT BY PROFESSOR W. C. UNWIN, F. R. S.

The plank dealt with, which was about 2¾ inches thick and

rather exceptionally dry (as the wetness test shows) is described as the timber of *Lagerstrœmia Flos-Reginæ*, or *Pyinma*. The colour of the wood is brown or light walnut.

A block, weighing 599·3 grams., was tested for density. The specific gravity was 0·669 and the heaviness 41·77 lbs. per cubic foot.

Some shavings dried in an oven at about 180° F. for eleven hours showed the amount of moisture in the timber to be 13·77 per cent reckoned on the weight of the dry wood.

Shearing Test.—Two tests were made : (*a*) with shearing plane about paralled to the annual rings, (*b*) with the shearing plane about at right angles to the annual rings.

(*a*) Block 69c.

Dimensions, 1·935 by 2·036 inches.
Area sheared, 3·939 sq. inches.
Shearing load, 3,588 lb.
Shearing stress, 910·8 lb. per sq. inch = 0·407 tons per sq. inch.

(*b*) Block 69d.

Dimensions, 1·985 by 1·980 inches.
Area sheared, 3·930 sq. inches
Shearing load, 2,349 lb.
Shearing stress, 597·7 lb per sq. inch = 0·267 tons per sq. inch.
Mean shearing resistance, 754 lb., or 0·337 tons per sq. inch.

Transverse Test.—Two tests were made with rectangular bars on a span of 45 inches.—

Bar 69a.—Width, 3·503 inches Depth, 2·592 ,,
Bar 69b.—Width, 3·629 inches Depth, 2·607 ,,

Load at centre, in pounds	Deflections, in inches.		Load at centre, in pounds	Deflections in inches.	
	69a.	69b.		69a.	69b.
0 ...	...	...	2,000 ...	0·569	0·677
250 ...	0·085	0·106	2,250 ...	...	0·736
500 ...	0·170	0·212	2,500 ...	0·927	0·787
750 ...	...	0·286	3,000 ...	...	1·036
1,000 ...	0·362	0·368	3,500 ..	...	1·256
1,250 ..	...	0·451	3,960 ...	Broke.	—
1,500 ...	0·520	0·526	4,000 ...	...	1·466
1,750 ...	..	0·572	4,398 ...	...	Broke.

Both Bars broke by tension.

The following are the results reduced :—

Bar.	Co-efficient of Transverse Strength.		Range of Stress, in pounds	Co-efficient of Elasticity.	
	Pounds.	Tons.		Lb. per sq. in.	Tons per sq. in.
69a ...	11,355	5.07	0 to 2,000	1,312,500	585·8
69b ...	12,037	5·37	0 to 2,500	1,125,400	502·4
Mean ...	11,696	5·22	..	218,950	544·1

Compression Test.—Two tests were made :—

Block 69e.—Dimensions, 2·452 by 2·499 inches.
Height, 6·55 inches.
Area crushed, 6·128 sq. inches.
Crushing load, 16·91 tons.
Crushing stress, 2·759 tons per sq. inch.

Block 69f.—Dimensions, 2·418 by 2·490 inches.
Height, 6·50 inches
Area crushed, 6·020 sq. inches.
Crushing load, 16·68 tons.
Crushing stress, 2·765 tons per sq. inch.

Both specimens broke fairly by shearing. The mean crushing resistance is 2·762 tons per sq. inch.

Considering that the wood is not very heavy, its strength is good.

11th November, 1896.

(*Annual Report of Imperial Institute* 1896-97.)

Preliminary Report on two Burmese Turpentines.

By Professor Henry E. Armstrong. F. R. S., &c.

Large samples of *Pinus khasya* and *Pinus Merkusii* have been received by me through the kind offices of the Imperial Institute, and the following are the results arrived at by their preliminary examination :—

The crude turpentine from *Pinus khasya* was a grey, thick pasty mass, containing a quantity of small pieces of wood. That from *Pinus Merkusii* was more fluid and cleaner in appearance.

By distilling with steam, I separated about 13/100ths of its weight of oil from the *Pinus khasya* turpentine, and nearly 19/100ths from the *Pinus Merkusii* turpentine. On a previous occasion, I obtained nearly 17 per cent. of oil from a sample

of the first-named turpentine. I imagine that the present supply of turpentine was collected under less favourable conditions, and that some oil was lost by evaporation in the case of the sample now under examination.

The original turpentine and the distilled oil in each case have a very slight but agreeable odour, which is even less pronounced than that of French turpentine and distinctly characteristic although indescribable. The two oils are very similar in this respect.

I am satisfied that the oil from *Pinus khasya* is identical with that which I received from the Colonial and Indian Exhibition and examined several years ago, and which I was then led to believe came from the same tree.

The examination of oils of this description, with a view to determine their precise composition, is a matter of great difficulty, and we are but beginning to discover methods. From the experiments I have been able to make thus far, I am satisfied that the oil from *Pinus khasya* is strictly comparable with French oil of turpentine, thus confirming the opinion I arrived at several years ago.

The oil from *Pinus Merkusii* is very similar to that from *Pinus khasya*.

Like French oil of turpentine, both these oils distil within a very narrow range of temperature, near to 155° C., but the oil from *Pinus khasya* appears to contain a somewhat larger proportion of some constituent of higher boiling point.

The two oils are very nearly alike in relative density, *viz.*,—

	P. khasya,	*P. Merkusii*
At 20° C. -	·8627	·8610,

They both turn the ray of polarised light to the right, the so-called specific rotatory power being,—

P. khasya	*P. Merkusii*
+36″28	+31″45

The rotatory power of French turpentine is practically always about 36″. Moreover, the *Pinus khasya* oil now examined agrees with that I previously obtained from British Burma in this respect.

Practically, French oil of turpentine and that from *Pinus khasya* exactly correspond in properties. The difference between the oils from the two Burmese turpentines is of such a kind as to be of no practical consequence—they are essentially similar, and the slight difference is due to the presence, in one or the other, of some substance *besides the chief constituent.*

I am at present inclined to think that the oil from *Pinus Merkusii* may be the more uniform. It will be my endeavour to thoroughly examine the two oils in comparison with French turpentine, and, *if possible,* to discover their exact nature.

Meanwhile, I may say that both oils are of the highest quality, and that I believe they would serve every purpose for which oil of turpentine (French or American) is used. They even compare favourably with the French oil, which is the highest quality in the market.

The resin left on distilling off the oil would also, I believe, be available for all purposes for which ordinary resin is used.

There is no reason, I venture to think, why India should not obtain whatever turpentine is required from native sources, if the industry can be developed and the cost of carriage be not too great.

I hope later on to submit a more detailed report, if I should be successful in devising methods of separating the constituents of the oils; and, in any case, to obtain results of considerable scientific interest which may throw light on the, at present, obscure relationship between the various oils of the turpentine class.

11th March, 1896.

(*Annual Report of Imperial Institute 1896-97.*)

Review of Forest Administration in British India for the year, 1895-96

BY B. RIBBENTROP C. I. E., INSPECTOR-GENERAL OF FORESTS.

Our usual yearly account of the Inspector-General's summary comes unfortunately rather late, but in spite of its lateness we think there is much that is important to record.

Area. During the year 1,544 square miles were added in the Bengal Presidency, 1,086 in Madras, and 199 in Bombay. There were 618 square miles of exclusions chiefly in the Central Provinces, so that the total area of Reserved Forest at the end of 1895-96 (June 30th) stood at 76,482 square miles. The area of Protected forest was 8,347 square miles and that of Unclassed forest 27,682 square miles, making a total of 112,511 square miles of all categories.

Forest Settlement was carried on more briskly during the year, especially in the Punjab, Burma and Madras, but in most provinces the work is nearly completed.

The Forest Survey continues to shew good work and the usual map recording progress is appended to the Review, the red patches on which shew the work of the year. The area surveyed was 5,677 square miles and the total now completed is 39,097 square miles. On the Subject of *Working Plans,* Mr. Ribbentrop says :—

"Of the total area under the control of the Forest Department, which at the close of the year stood at 78,474 square 'miles, working-plans were actually in force over an area of '10,670 square miles, or 14 per cent. of the whole. Moreover, '*for a further area of more than 15,000* square miles, working-'plans were under preparation, so that it is evident that the next 'few years will largely increase the area of forests worked under 'carefully considered plans of working. During the year under 'review, 15 working-plans, dealing with an area of 1,495 square 'miles, were sanctioned by Local Governments, raising the 'total number of plans in force from 50 to 64, whilst 11 plans, 'dealing with 1,670 square miles, were submitted to the Inspec-'tor-General of Forests for his professional opinion.

'The North-Western Provinces and Oudh continue to hold '*the foremost place in this branch of administration*, showing an 'area of 59 per cent. of the total brought under sanctioned work-'ing, whilst important plans for some 1,000 square miles, were 'either completed or nearing completion at the close of the year. 'Excellent progress has also been made in the Southern Circle 'of the Central Provinces. In Madras and Bombay the control 'of working-plans does not lie with the Government of India, and 'it is not known how far the plans referred to in the reports and 'forms have been sanctioned by the Government. But it would 'appear that in Madras better progress was made than in the 'previous year, and that in *Bombay a good deal of* work was 'done in all three Circles. The high cost of completed plans in 'the Kanara Division of the Southern Circle, Rs. 545 to 'Rs. 649 per square mile—is remarkable. In Sindh it has been 'realized that the forests have in many instances been overworked, 'and the long delayed formation of a working-plan division is 'a most satisfactory step."

Communications and Buildings. The following account will be read with interest, and especially the part relating to forest tramways. It is not clear whether it has been sufficiently considered in the calculations, which are in some cases against the use of the tramway, that the use of carts is in some of the localities nearly impossible, that very often the number of available carts is very small compared with that required ; and that it may often happen that if carts were used, much more expensive roads would have to be made. Thus, in Striharikota, the soil is a deep loose sand most difficult for carts ; there are no, or almost no roads, and the forest being nearly quite separated by water from the agricultural country, carts would be difficult to procure in numbers sufficient for the carriage of the wood.

Again, in Cuddapah (*Ballipalle?*) and in the Anamalais the country is difficult, and road work would be expensive if tracks suitable for the carriage of heavy loads had to be made. In the Casuarina plantations of Nellore, the use of carts would be almost

impossible, and like Striharikota, the soil is a loose sand. Another year we may hope to have a paragraph devoted to wire tramways: in our opinion wire is the method of transit of the future, only we must get the latest improved arrangements from Europe or America instead of putting up more or less rough appliances as has sometimes been done. We believe that wire is much used in Ceylon and it is certainly used on the Nilgiri Coffee estates: it ought to be excellent for forest works, especially if the gradients can be managed so as not to be too steep.

"On the construction and up-keep of communications a total 'expenditure of Rs. 1,43,800 was incurred, of which Rs. 51,100 'were spent on new roads. Only in Bengal, the North-Western 'Provinces and Oudh, and in Madras were important new road-'works undertaken, expenditure in the remaining provinces being 'but small. Rupees 92,700 were spent on repairs to existing 'roads, the heaviest expenditure being, as usual, in the North-'Western Provinces and Oudh (Rs. 43,000), where extensive 'annual repairs to the roads are required, without which produce 'cannot be brought out of the forests. The construction of tram-'ways for the carriage of produce from the forests to the markets 'has not been developed to any great extent, there being at 'present only some 32 miles of such lines, of which only 28 'miles have been laid. Moreover, where such works have been 'constructed, they have not always proved commercially suc-'cessful as compared with the ordinary means of transport obtain-'able locally. Thus, in Madras, the Anamalai tramway in the 'South Coimbatore District, which has been kept up since '1889-90, is calculated to have resulted in a net loss to Govern-'ment of Rs. 22,000. The cost of carriage by the tramway is 'Re. 1-6-1 per ton per mile, whilst by carts it is estimated to be 'Re. 1-0-8 per ton per mile. The capital on which depreciation 'and interest is yearly deducted would, however, seem to include 7 'miles of tramway, of which 4 miles only are at present laid, and 'it is probable that when the lead is longer the tramway will 'show a profit. Similarly, in the case of the Cuddapah tramway, 'the working of which still shows a slight loss, out of 3 miles of 'line purchased only 1½ mile seem to have been laid.

'The Casuarina Plantation Range tramway in Nellore has, 'on the other hand, proved a complete success during the 11 'years in which it has been working, and the net profit to 'Government during this period is estimated to have been Rs. '23,600. In Changa Manga, where a tramway 4 miles in length 'has been working for some 17 years, the cost of carriage of fuel 'by tramway has been much the same as it would have been had 'country carts, paid at prevailing rates, been employed. But the 'number of local carts is quite insufficient for the work, others 'would have to be imported from elsewhere and the rates would 'certainly rise.

'The following statement gives particulars of the forest tram-'ways at present working in India, and an endeavour has been 'made to contrast the cost of carriage per 100 maunds by the 'various tramways, with that by other means of transport obtain-'able in the same locality":—

1	2	3	4	5	6	7
Total length of tramway.	Gauge.	Description, and weight of rails.	Motive-power.	Capital outlay per mile.	Working expenses per 100 Mds. per mile.	Cost of carriage of 100 mds. per mile by other means in similar localities.
		Changa Manga.		Rs.		
4 miles ..	16 inch	Surface level; no preparation required for laying tram, the direction of which is changed as required.	Bullocks.	6,955	Re. 0-14-3 (includes interest at 4 per cent. on capital outlay, estimated value of wear and tear and working expenses).	Re. 0-10-11.
		Andamans.				
6½ miles ..	2 feet	Steel, 18 lbs. per yard.	Manual labour and draft animals.	9,322	Re. 1-0-1 (includes depreciation on cost of rail material at 10 per cent).	Cart transport pays only where small quantities of timber are to be brought from scattered fellings.
		Sriharikota.				
5½ miles ..	2 feet	Steel, 14 lbs. per yard, with steel corrugated sleepers and wrought steel chairs riveted on full width of sleepers.	Manual labour.	4,295	Re. 1-0-10 (includes interest on capital at 4 per cent. and 6 per cent. for wear and tear).	Re. 1-0-3.
		Kottapatam Casuarina Plantation.				
4 miles ..	2 feet	Steel, 14 lbs. per yard, with steel corrugated sleepers and wrought steel chairs riveted on full width of sleepers.	Bullocks.	10,489	(*a*) Re. 1-10-0 (includes interest on capital at 4 per cent. and 6 per cent. for wear and tear).	Re. 1-2-6.
		Anamalai.				
7 miles (4 miles and 5 furlongs only laid).	2 feet	Steel, 14 lbs. per yard, with steel corrugated sleepers and wrought steel chairs riveted on full width of sleepers.	Manual labour.	5,261	Re. 1-4-10 (includes interest on capital at 4 per cent. and 6 per cent. for wear and tear).	Re. 3-1-5.

	2	3	4	5	6	7
Total length of tramway.	Gauge.	Description, and weight of rails.	Motive-power.	Capital outlay per mile.	Working expenses per 100 Mds. per mile.	Cost of carriage of 100 Mds. per mile by other means in similar localities.
		Cuddapah.				
8½ miles (only 1½ mile permanently laid, the remainder is used for lines required temporarily.	2 feet	Steel, 10 lbs. per yard.	Manual labour.	..	(*b*) Rs. 4-8-8 includes interest on capital outlay at 4 per cent).	Rs. 3-4-0 by double bullock cart.

The above tramway material was obtained either through the India Office, Messrs. King, King & Co., Bombay, or from Messrs. John Fowler & Co., Leeds, whose agents in Calcutta have an office at No 89, Clive Street.

(*a*) Comparatively high rate due to greater expense of working tramway in hilly country.

(*b*) Information not available as to the comparatively high cost of working. Doubt is expressed if there will be sufficient material or sufficient steady demand to make the line pay.

Fire Protection.—The year was rather a bad one and many serious fires took place. Still, on the whole, the results were good, for out of 30,631 sq. miles attempted, 27,909 were protected successfully; that is, 8·9 per cent of the area was burnt. The cost of protection came to about 2 pies per acre. On the causes of fire Mr. Ribbentrop remarks:—

"In the Bengal Presidency, 1,187 conflagrations occurring 'in fire-protected forests were attributed to intentional firing. 'In the large majority of cases this was not, it may be assumed, 'done with malicious intent, but in order to obtain new grass 'for purposes of shikar or through mere carelessness. It is 'astonishing how difficult it is to impress upon the uneducated 'native mind the amount of damage that is done by setting 'light to a forest. They will not realize it, and it requires 'time and patience and help from the Revenue authorities to 'educate the natives in this respect and to eradicate inherited habits; but it is evident from the constant increase of the areas which in most provinces escape being burnt without special means of protection, that considerable progress has been made in teaching the necessary respect for forest property. Exemplary punishments are needed only where malice has 'been proved."

Grazing.—An interesting table gives the areas open and closed during the year, from which we gather that of all classes of forests, totalling 112,511 square miles, 33,316 were closed to all animals and 38,419 to browsing animals only. The Inspector-General explains how extremely liberal is the Government

policy as regards grazing, in a table, which shows that while Rs. 15,04,000 were realized for grazing during the year; nearly as much, viz., Rs. 14,30,000 were foregone.

Reproduction. The following are Mr. Ribbentrop's remarks on this subject. His remarks are followed by a note on the fire question in Burma which is too long to reproduce here but deserves a place to itself which we hope to give it later.

"Our working-plans prove that considerable attention is 'paid to the application of correct sylvicultural principles to 'our Indian forests. The progress in this direction has been 'good, and the treatment under which the principal timber-'producing species most successfully reproduce themselves is now 'generally understood. The majority of officers in the high grades, 'and many of those who were educated at the Dehra Forest School 'occupy themselves with the study and solution of sylvicultural 'problems to an extent quite unknown not so very many years 'ago, when these studies were, so to say, the monopoly of 'a few officers in each Province. This growing interest in 'sylvicultural problems, the more general and more scientific 'applications of the principles taught to our officers during 'their technical training may be ascribed to three main causes.

'In the first instance there has been a considerable increase 'in the numerical strength of Divisonal Officers, and in the 'proportion of technically-trained men amongst them.

'The next reason is the great improvement which has 'taken place both numerically and in general efficiency in the 'India-trained staff, more especially in the Provincial and 'Ranger services. This naturally has its effect on the lower 'subordinate class, and the Divisional Officer is less a slave 'of close supervision over the executive carrying out of sylvi-'cultural operations than he used to be, at a time not so far 'back, when he had to personally supervise each thinning, and 'the marking-out of each improvement or regeneration felling.

'The third and by no means the least important cause is 'found in the preparation of working plans and the present 'centralization of their criticism and control. Each of such 'plans, or at least groups, which refer to forests of a similar 'character, contain sylvicultural problems and proposals to 'solve them by practical application of sound sylvicultural 'principles. No doubt sooner or later the valuable information 'now scattered through many volumes will result in mono-'graphs on the treatment of special distinct classes of forests. 'In the meantime we may well be satisfied with the general 'progress made in the study of Indian sylviculture and its 'practical application, and especially with the general interest 'taken in this, the Forester's most important duty; for 'though we have learned much there is still much more to learn.

'Natural reproduction is so gradual and so few exceptional

'incidents occur, that it serves no practical purpose to record 'progress from year to year. The two main conditions which 'are necessary to obtain a satisfatory reproduction are a per- 'manent protection from fire and from grazing whilst reproduc- 'tion is actually in progress."

Outturn.--The total outturn of the forests in the whole of British India for 1895-96 was

	Government.	*Purchasers.*
Timber c. ft.	6,226,099	40,194,745
Fuel c. ft. ...	18,264,220	90,763,705
Bamboos No. ...	11,092,111	1,29,461,778
Minor Produce Rs.	1,20,529	33,66,978

In addition to the above, produce, etc, of the following value was given away free:

	Rs.
Timber ...	3,09,620
Fuel ...	11,10,350
Bamboos ...	1,04,020
Minor Produce ...	2,99,560
Grass and Grazing	16,87,100
Total ...	36,00,650

Finance.—The *gross* revenue of the year was Rs. 1,70,99,380; the *net* revenue Rs. 77,66,770 which amounts to 45.4 per cent. of the gross revenue, a little larger than in 1894-95 and to Rs. 69 per square mile of land under forest control.

The value of produce given away *free* was Rs. 36,00,650 as before stated so that the net results of the year were

Actual net revenue	77,66 770
Free grants and rights ...	36,00,650
	1,13,67,420

Mr. Ribbentrop very properly remarks that "these facts show 'the great value of the Government forest estates, apart from 'the revenue realized from them, in supplying the needs of the 'surrounding population."

And yet no account is taken of the indirect advantage to the country in having an assured free or cheap supply of the material which it requires for everyday use. Many forests are worked at only a very slight profit indeed to the Government, but a very large indirect advantage to the governed. We should like to see a step further taken and the advantages which the population living near the forests possesses, extended to that which has no forest near at hand. If the 'fuel and fodder' scheme proposed by Dr. Voelcker were extended to the large areas of those provinces whose forests are in large Blocks only, on their

outskirts, we might hope that the result would eventually be the restoration to the land of the immense quantity of manure now used as fuel.

Experiments.—we reproduce the following extracts on the resin industry and the india rubber plantations :

"An attempt was made to extend the resin works, which 'have proved entirely successful in the hill forests of the Jaunsar 'Division, to the "*chir*" trees grown in the Saharunpur Division. 'The amount of resin yielded by these trees growing somewhat 'out of their natural habitat was found to be so small that the 'attempt was abandoned. The comparative absence of resin in 'trees of the same species, which produce an abundance at higher 'elevations close by, is a fact worthy of notice. Further experi-'ments will be carried out in regard to this and will also be un-'dertaken in order to ascertain the comparative yield of the 'rubber-trees in different localities. Without such precautions 'large sums of money may be frittered away.

'The Charduar rubber plantation in Assam was enlarged 'by a few acres only. It covers an area of 2,165 acres, and has 'been a complete success so far as the propagation of the rubber-'tree (*Ficus elastica*) is concerned.

'The best method of propagation has been found to be by 'raising plants from seed in nurseries, where they are transplanted 'two or three times and kept until they are some 12 feet high. 'They are then planted out in mounds and are high enough to 'be out of the reach of deer, which destroy small young seed-'lings. Rubber-trees may also be raised from cuttings, but so far 'the information at present available tends to show that the 'plants thus raised are not so hardy, and that they do not throw 'down aërial roots nearly so quickly as the plants raised from seed, and that consequently they take much longer to develop 'and at any given age yield less rubber.

'Experiments have also been made of planting out the young 'rubber in the forks of trees, a method which has the advantage 'of at once placing them out of the reach of their great enemies, 'elephants and deer, and of giving them the necessary light over-'head without the necessity of making extensive and expensive 'clearances in the evergreen forests. These experiments have 'usually failed, principally, it is thought, because too often the plants were placed in the forks of sound trees. In many cases sufficient nourishment was provided to keep them alive, but no inducement was offered to establish a connection with the soil. It is a matter of regret that the experiment was abandoned and that the forest was cleared for a regular extension of the plantation, instead of trying to induce the plants established in the forks of trees to connect themselves with the soil. Further experiments 'seem desirable in this direction. The young plants should, how-'ever, be placed in unsound or girdled trees, or some device, such

'as hollow bamboos filled with vegetable mould should be 'arranged, so as to enable the rubber roots to develop and reach the 'ground. Once they have done this their subsequent satisfactory 'growth is assured, and it is evident that this method, merely neces-'sitating the killing out of a few practically valueless trees, must 'be infinitely cheaper than opening out belts in the evergreen forests 'and the clearing thereof for several years, the building of mounds, 'and the raising of large plants. It has been estimated that, with the 'experience gained from past experiments and failures, it is pos-'sible to plant up an acre with rubber raised from seed at a cost 'not exceeding Rs 40 per acre; and this may be much less if 'grass land is operated upon.

'Fifty rubber-trees, planted out in 1874, had in 1895, at 'the age of 21 years, an average height of 78 feet and an aver-'age girth of 18 feet at the base. Trees 15 years old were found 'to have an average height of 64 feet with a girth of 9 feet. 'It remains, however, to be proved whether the plantation will 'prove a financial success or not.

'*Exports of Forest-Produce.*—The following table gives the 'amounts and value of various articles exported from India during 'the year:—

Articles of forest-produce.	Quantity in tons of 20 cwt.; in the case of Teak cubic tons.		Valuation at port of shipment in 1895-96.	
	Average of five years, 1890-91 to 1894-95	In 1895-96.	Total.	Per ton.
			Rs.	Rs.
Caoutchouc	473	352	9,91,356	2,816
Lac—				
Button	1,375	1,948	36,29,890	1,863
Shell	5,503	8,134	1,46,31,466	1,798
Stick and other kinds ...	76	58	75,654	1,304
Lac-dye	9	¾	1,705	2,273
Sandal-wood, ebony and other ornamental woods. ...	Information not available	...	9,37,759	...
Cutch and gambier	9,250	9,186	37,96,106	413
Myrabolams	41,672	50,001	40,45,598	81
Teak	50,361	63,516	67,09,744	105
Cardamoms	123	63	1,95,744	3,107
Total in 1895-96 ...	...	133,258	3,50,15,022	...
" 1894-95 ...	...	134,028	2,93,98,186	...
Difference in 1895-96 ...	...	—770	+56,16,836	...

The Inspector-General notes that the past ten years have seen the exports of forest produce more than doubled in value as is shown by the following comparison :—

Value of exports in	1885-86	...	Rs. 1,71,00,000
Ditto	1895-96	...	,, 3,50,00,000

Education.—It is noted that 11 officers joined the Department during the year from Coopers Hill; and that there were 83 students at Dehra Dun.

We will new conclude by quoting Mr. Ribbentrop's remarks on the Forest Administration in native States. We regret, as last year, to see Travancore omitted from reference, also Hyderabad, Kolhapur, Mohurbhanj and others which have commenced forest conservancy. It would surely not be difficult to obtain information regarding these, even though the States do not issue printed Annual Reports.

"Copies of the Forest Administration Reports were received 'from the Mysore, Kashmir, Jodhpore, and Jeypore Native States. 'In Mysore, Mr. L. Ricketts, who retired towards the end of '1895, was replaced by Colonel Campbell-Walker. Owing main-'ly to a slackness in demand for sandal-wood, the forest revenue 'in this State decreased slightly as compared with the results of '1894-95, but, on the other hand, the area of the "State Forests" 'was increased by 141 square miles; while a commencement 'was made toward systematic management by starting enumera-'tion of sandal trees in all the districts. It is observed that the 'question of forming further considerable areas into "Reserves" 'and "State Forests" is being considered by the Durbar, that 'some little progress was made in preliminary surveys of reserv-'ed areas, but that a large amount of work still remains to be 'carried out as regards demarcation and forest-settlements before 'any great progress can be made in the preparation of work-'ing-plans.

'In Kashmir the net revenue rose from Rs. 3,39,000 to 'Rs. 5,36,360, this large increase being due to an extension in the 'departmental sleeper works. Excellent progress has also been 'made in the estimation of forest areas, in demarcation and in 'boundary surveys, and the Government of India view with 'satisfaction the great advance made in the management of 'the forests during the past five years of Mr. McDonell's admin-'istration. At the same time it is trusted that the importance 'of taking measures to ascertain the permanent possibility of these 'very valuable deodar forests will not be lost sight of.

'The forest administration in Jeypore and Jodhpore con-'tinues to be satisfactorily carried out, though the number of 'browsers shown as grazing in the open forests in Jeypore seems 'to be somewhat excessive, as the figures given in Forms Nos. '54 and 55 show that 78,000 acres of forest were grazed over 'by 153,082 of these animals. Concerning forest conservancy

in States that do no not issue printed Administration Reports, 'it is to be noticed that Mr. Thompson, lately Conservator of 'Forests in the Central Provinces, has *been appointed to the* 'charge of the Sirmur State forests, and that the preparation of 'simple working-schemes for the numerous small States surrounding Simla has been commenced."

V.—SHIKAR AND TRAVEL.

The Hill route from Mussoorie to Simla.

I have occasionally seen in the "Pioneer," and I think other papers, enquiries about this route, which is, or should be, a favourite one with officers on their way to or returning from Simla who wish to see a little of the Hill country and do a little *shikar* on the way. It is strange that a route formerly so much frequented should of late have fallen so much into disuse and that difficulties should be found by those who wish to know what accommodation there is along it. In Newman's "Railway Guide" there is, or used to be, an itinerary which is misleading and to a great extent wrong. As, therefore, I made the journey in the spring of 1895 and as I am well acquainted with the eastern part of the country traversed, I think it may be not uninteresting to put on record a few notes on the subject.

The way to Mussoorie is well known, travellers leave the train at Saharanpur, travel by tonga or dak ghari to Rajpur above Dehra Dún and ascend thence riding, or in jhampans, to Mussoorie. From Mussoorie to Chakrata, there is an excellent bridle road, which leaves the Mall a little to the East of the Charleville Hotel, and descends first through pretty woods of oak, rhododendron, laurels, etc. and then through fields or patches of scrub forest to (8 m.), the District Road Bungalow of Sainjni. There is no Khansamah, so that travellers (who must previously obtain permission from the Superintendent of the Dún) must have their own servants and supplies. Thence the road descends, partly through cultivated lands, partly through forest of deciduous plains trees, to the suspension bridge over the Jumna. The valley is very hot and between March and November it is advisable to cross it either early in the morning or late in the evening. From the Jumna the road ascends for about $1\frac{1}{2}$ mile to the Dak Bungalow at Lakhwar (16 miles from Mussoorie) where there is a Khansamah who supplies food when required. The village of Lakhwar is interesting as an excellent specimen of hill architecture. There is a picturesque temple with a flagged courtyard. After Lakhwar, the road rises gradually round the somewhat bare slopes of a mountain overlooking the Jumna, to a District Road Bungalow at Nagthat, where a magnificent view of the Snowy Range is obtainable in clear weather. The bungalow is good and can be occupied, with permission of the Superintendent of the Dún, by travellers who have their own servants and provisions. After Nagthat, the road rises again through woods of pollarded oak and rhododendron to the excellent and

pretty little Dak Bungalow at Chauranipani (11 miles from Lakhwar). This bungalow, where there is a Khansama and supplies are available, lies high up, at an elevation of about 7,500 feet and has a fine view, though the Snowy Range is not so well seen as it is from Nagthat. From Chauranipani the road goes level for a while through oak forest, then descends for some distance and after rounding several spurs more or less at a level, rises steeply over very bare steep hill sides to the crest of the ridge on which Chakrata is situated, descending again to the point (called Charing Cross) where the bridle path from Kalsi joins it and a short distance further to the Dak Bungalow (Khansama and supplies) the very first house in the station, 11 miles from Chauranipani. Thus, travellers who use the Dak Bungalows will march (1) Mussoorie to Lakhwar 16 m.
(2) Lakhwar to Chaurani 11 m.
(3) Chaurani to Chakrata 11 m.

while those who prefer it, and have their own camp arrangements, can travel (1) Mussoorie to Sainjni 8 m.
(2) Sainjni to Nagthat 13 m.
(3) Nagthat to Chakrata 17 m.

Travellers who start from Mussoorie can obtain baggage mules or coolies from the bazar chaudhri, to go the whole distance.

The Military Cantonment of Chakrata lies on a long ridge and the distance from the Dak Bungalow at one end to the beginning of the Dooban ascent or Morrow's Neck at the other, is about 2 miles. Chakrata is also reached direct from Saharanpur by the fine military cart road (70 miles) the stopping places on the way being the following, only one being a regular Dak Bungalow.

	Miles	
Saharanpur to Kalsia	12	Canal Bungalow / Mily. Works Bungalow.
Kalsia to Badshahibagh	10	,, ,, ,,
Badshahibagh to Fatehpur	12	do.
Fatehpur to Tilwari (Kalsi)	10	do. and Dak Bungalow
Tilwari to Saia	10	Mily. Works Bungalow.
Saia to Korwa	8	do.
Korwa to Chakrata	8	Dak Bungalow

From Saia, however, there is the bridle path already mentioned which shortens the route by some 5 miles.

The road from Chakrata on to Simla is practically divided into three sections (1) from Chakrata through the British territory of Jaunsar-Bawar across the Tons to the boundary of the Simla Hill States jurisdiction ; (2) through the Hill States to Fagu on the great Simla-Tibet road, and (3) thence into Simla. In the *first* section, the traveller must either camp or use the Forest Department Rest-houses ; in the *second* he has no

alternative but to camp, for the rest-houses, if ever they existed, have disappeared; and in the *third* it is only one long march from the excellent and large Dak Bungalow at Fagu into Simla. In the *first* section, carriage is only obtainable from the villages with the help of the Forest Officers, or, still better, with the assistance of a revenue peon obtained through the Assistant Magistrate at Chakrata who is also the Cantonment Magistrate of the Station. Indeed, all travellers, whether starting from Chakrata, or entering the District from the West, are strongly recommended to write to the Cantonment Magistrate and obtain from him the necessary "parwanas" and, if possible, the services of a peon. Otherwise, they may be delayed, as coolies will not ordinarily go more than one march and cannot be obliged to do more. Travellers are also strongly advised to pay their coolies personally and, if possible, separately, and not to make their disbursements through their servants, for the hill-men will not put up with any levy of "dusturi" and will make complaints if not fully and correctly paid. In the *second* and *third* sections, there are regular halting places and at each of these there is a Chaudhri who is expected to provide carriage to the next, at fixed tariff rates, but as long notice as possible has to be given him to prevent delay.

For the journey through Jaunsar, in former years, the old Simla road was the regular route. This road, which is still open, though very steep and very rough in places, leaves the present regular road at Deoban (5 m. from the Chakrata Dak Bungalow) descends from thence into the Binalgadh and climbs again to (2) Bandrauli, then follows the Tons river but high above it, till it falls to (3) Dharagadh, and thence, after crossing a high spur (Kanda village) descends to the Tons and follows it to (4) Tiuni at the bridge, It is a hot route and not very interesting, so that the traveller is strongly advised to travel by the "Tons road," a fine bridle path maintained partly from District, partly from Forest funds, and passing through some of the finest Himalayan scenery.

On this road the regular marches are

(1) Deoban 5 m.
(2) Mundali 13 m. or Lokar 19 m.
(3) Kathian 8 or 6 miles.
(4) Tiuni 12 miles.

From Chakrata Dak Bungalow the road passes through the Cantonment for 3 miles and then ascends steeply, first through forest of oaks (*Quercus incana* and *dilatata*), then along grassy hillsides and then again through forest of fir (*Abies Smithiana* and *Webbiana*) and oak (the kharshu *Quercus semecarpifolia*) to the Forest Rest house at Deoban. For the use of this and other Forest Rest houses, application should be made previously to the Divisional Forest Officer at Chakrata and dates arranged with

him, otherwise the traveller is liable to find them occupied by forest officers or by other travellers. The Deoban Rest-house is an old one, built about 1855, and for some time used as a Dak Bungalow, then, as it was no longer required for that purpose, it was taken over by the Forest Department who have enlarged it and who maintain it as an important Forest centre. It is about 9,000 feet above the sea. From both the peaks of Deoban, 'Chakrata View' to the south, and 'Snow View' to the north, fine views of the Snowy Range are obtainable and there are several interesting and pretty walks and rides in the forest around. The next march to Mundali takes the traveller along close to the main ridge of the water parting of the Tons and Jumna rivers through most beautiful scenery with lovely views, *the finest of all being perhaps that from the* Karama pass (9,800 feet) at the top of the descent to Mundali, where there is a comfortable forest Rest-house. It does not lie on the main Tons road but on a branch from the above-mentioned pass, and the main road is re-gained by either of two alternative lower roads. If the Mundali house should be occupied, the Lokar hut on the main road a little further on, can be used instead. Mundali lies in one of the finest pieces of Deodar forest in the hills and the firs and oaks close by are of enormous size and great height. From Mundali or Lokar to Kathian the road winds round the spurs at the head of the Dharagadh valley partly through forest, but chiefly through cultivation or grassy pasture lands. At Kathian is another forest rest-house hidden in deodar forest but with a fine view. It lies at the head of the Dharmigadh valley leading into the upper Tons, across which are seen the Rikshin and Chansil ranges of Tehri-Garhwal. From Kathian, two roads descend to Tiuni at the Tons bridge (3,000 feet) ; the chief, the main road, and the most interesting, going down the Dharmigadh through forests of long-leaved Pine to the Tons at Maindrot (a foot-bridge), and then down along the Tons to the bridge allowing a fine view of the meeting of waters of the Pabar with those of the Tons ; the other, rather shorter, but narrower and less pretty, going over the hill and down direct to the bridge through a large village called Koti Bawar. The former should be taken in cold weather, the latter in the hot season, as it gives less of the heat of the valley. At Tiuni, a forest Rest-house has been recently completed, but after this point tents are necessary until Fagu is reached. So far, the road is an excellent broad bridle path, all dangerous places being protected by railings, but from Tiuni to Fagu the road is not so good and in places is very bad, so that only a hill pony can be taken without risk. From Chakrata to Tiuni the road is quite well known, but west of the latter place it is less so and it is this part for which information seems wanted.

The Tons is crossed by a suspension bridge and then the path winds round the hillside above the river till it meets the valley of the Chandnigadh where may be seen the remains of an old timber sledge road which was used in working the forests of Murach at the head of the valley.

The road goes up the valley for about a mile and then crosses the river and ascends by zigzags through a fir forest of the Chir pine (*Pinus longifolia*) to the village of Natang, then through cultivated land to Mundhole (6,250 feet) where there once was a Dák Bungalow. At Mundhole, forest of the Kail pine (*Pinus excelsa*) is entered and this forest extends all the way up to the pass (Pushrar Pass) at an elevation of nearly 8,000 feet. All this latter part of the way, the road is the boundary between the Jubal State on the left and the Government lands of Jaunsar on the right, but after the pass, the Simla Hill States are entered and traversed all the way to Simla. The road from Tiuni to the Pushrar pass is fairly good, through rather steep in places, and those travellers who do not camp at Mundhole, should stop near the pass as it is a very heavy march for coolies or mules right through to Tikri or Butchra. At about 1½ mile off on the right and some 400 feet higher, is the one-roomed forest hut of Murach with a good camping ground but rather far from water. From here, paths go into the deodar forests and up the ridge towards Taroche, Dadi and Raiengarh. Not far from Murach is the place where, in 1870, Mr. Walter Henman, Assistant Conservator of Forests, was killed by falling over a precipice.

After leaving Murach or a camp at the pass, the road descends the hill to the stream and after crossing that stream ascends again to the village of Tikri, in a rather exposed position on a spur; and then winds down under the village through cultivated lands and pollarded forest to the camping ground at Butchra. From thence it goes on down again to a stream and after rounding a very bare spur, chiefly noticeable for its many *Euphorbia* bushes, finally descends to the Shallu river. Thence the Shallu river is followed and finally crossed by a rough wooden bridge and an ascent is made to the pretty camping ground of Piuntra amid streams of clear water and villages with houses of quaint Swiss-like architecture. At the camping ground is the grave of a child of a former Deputy Commissioner of Simla. Piuntra lies at about 4,500 ft. altitude and is consequently rather warm in the hot season, but the neighbourhood is very pretty and attractive.

After leaving Piuntra, a descent is again made to the Shallu river, which the path follows for several miles, over flats and through cultivation and small patches of forest to Neoti, after which it ascends with a long steep ascent, through cultivation or along bare rocky hillsides to Chepal where the camping

ground among the deodars looks down on the picturesque summer palace of the Ranas of Jubal, a quaint building with overhanging eaves and balconies. Opposite the camp are seen the thick forests of the Chor mountain whose top is only too often wrapped in cloud. To the forest officer, the forest round Chepal is interesting on account of the very fine reproduction of deodar, probably the result of recent measures of conservancy.

The road, after leaving Chepal, is a steady ascent through forest of deodar, pines, fir and oak, but in places it is very bad, more like the bed of a water course than a road that had once been properly made. On the way, a branch road is passed which leads off to the Chor and finally the summit is reached at about 9,600 ft. in forests of kharshu oak and ancient yews. Magnificent views are to be had here and there, but the writer can say but little about them for it was on this march that he encountered the first burst of the monsoon and was consequently marching the whole day in torrents of rain and enveloped in cloud. Paternala, the camping ground, is but a small sloping oasis with space for a few tents only, in a forest of silver fir, and unless necessary, travellers are advised to try and make the double march on to Daha. The road from Paternala to Daha follows down a long spur, for the most part above precipitous rocks and in a forest in which the Kail is the most conspicuous tree. Towards the end, after passing a sort of roadside shelter near a village, a steep descent leads through a beautiful forest of firs and oak, rich with ferns and foliage plants, to the camping ground at Daha. This ground is rather far from the village and supplies and so it is better for those with only small camps to obtain leave to camp in a fruit garden near the village among the apricot trees. Daha is in the native State of Bulsun, whose chief lives in a large village conspicuously visible on a spur below.

On leaving Daha the road winds down the hill, partly though cultivated lands studded with fruit trees, partly though forests of pollarded oak (*Quercus dilatata*) remarkable for the extraordinary growth on them of the parasite *Loranthus cordifolius*, to the village of Bagri and then more steeply to a river which is crossed by a good bridge, near a very picturesque old village perched on a rock in a bend of the stream. Here the road rises again to another village where it crosses the spur and descends to the Giri river which has to be forded below the curious fortress-like houses of Sainj. To those whose marches are short, Sainj will probably be the camping ground, but for those who are in a hurry, it is quite possible to proceed on to the fine Dák Bungalow at Fagu. The road follows the Giri for a while through rice fields and round rocky spurs and then after crossing two rivers ascends steeply up a nearly bare spur to the road near Fagu.

From Fagu to Simla the road is well known and needs no special description, it is a fine road, nearly level to Mahasu, then descending to the Mashobra tollbar, then level round rocky spurs and through a tunnel to Sinjoli and then fairly level again into Simla.

The marches on this last section of the way are :—

Tiuni to Murách	10 Miles			
Thence to Piuntra	9 ,,	Daha to Sainj	7	Miles.
Piuntra to Chepal	10 ,,	Sainj to Fagu	8	,,
Chepal to Paternala	8 ,,	Fagu to Simla	12	,,
Paternala to Daha	6 ,,			

There are no houses to rest in, except at Fagu, so tents are required everywhere. The length of the whole route from Mussoorie to Simla is 146 miles, *viz* .—

Mussoorie to Chakrata	38
Chakrata to Murach	48
Murach to Fagu	48
Fagu to Simla	12
	146

The whole march is an interesting one and gives a good idea of the outer Himalaya, its villages, cultivation and forests, its rivers and rocks. The map and section appended, the latter the work of a traveller some years ago, Captain Richardson, R. A., will help in shewing the varied nature of the country on the section of the road between the Tons river and Fagu.

J. S. GAMBLE.

VI.—EXTRACTS, NOTES AND QUERIES.

The Indiarubber and Guttapercha Industrfes.

AS APPLIED TO ELECTRICAL ENGINEERING.

Indiarubber or caoutchouc, as it is sometimes called from the original native name cachuchu, was described in 1736 in a communication made to the French Academy as the inspissated juice of a tree growing in South America, and was not introduced into Great Britain until 1770, being regarded up to that time somewhat in the light of a curiosity having no practical value. Even then on its primary introduction, it was used purely and simply as a pencil eraser. It was not until the year 1823, fifty years after its introduction into the Kingdom, that it was, from experiments which had

been made on it by Mr. Mackintosh of Glasgow, found to be of practical value for its waterproof qualities.

It is obtained by drying the milky juice of trees belonging to various vegetable families. The original supply was obtained from a tree of the *Euphorbiaceæ* family known as *Siphonia elastica*, which is found on the land forming the basin of the Amazon River. It is a tall tree, attaining, as it does, a height of from forty to fifty feet before throwing off any branches and ultimately reaching a height of from eighty to a hundred feet. The trunk is not large in proportion to the height, being from two to two feet six inches in diameter. The foliage is thick and bushy.

The milk may, in reality, be collected at any time of the year, but is, as a rule, tapped during the dry season, which extends between the months of August and February. The method of procedure is as follows:—

An incision is made in the trunk of each tree some five or six feet from the ground, on which, in a convenient position to catch and retain the exudation, are placed rough cup-shaped vessels made of clay. These are then left until the following morning, when the milk is collected from the cups, the quantity of course varying but averaging about a gill for each incision. Fresh tappings are then made and the operation repeated, the tree usually becoming exhausted after the fourth trial. When the milk has all been drawn off in this manner, the exhausted tree must be left for a period of two years to recover itself before being tapped again.

The milk having been collected, is poured into larger vessels, and the drying process, which results in the actual manufacture of the rubber, is commenced.

A number of clay moulds are first made in the shape of bottles, &c., and are then dipped in the milk and hung up to dry over a fire, the principal fuel of which consists of Inaja nuts and which gives rise to a thick greasy smoke. The first dipping having been dried in this manner, the process is repeated until a thick coating of rubber has been deposited on the mould. The oily smoke of the drying fire is responsible for the dark colour of the manufactured rubber.

In India the caoutchouc is obtained from a species of tree known as *Ficus elastica*, which belongs to the family *Artocarpaceæ*. It is indigenous to the forests of Assam and has a rapid growth, reaching a height of from eighty to a hundred feet and throwing out branches to a distance of seventy-five feet in all directions. The larger of these branches throw out roots at their extremities after the manner of the well-known banyan tree which, in fact, belongs to the same family.

The tappings in this case are made in the bark of the trunk at a point where the roots branch out, the latter being generally exposed. The oldest and largest trees are chosen for the purpose and may be tapped fortnightly, the average amount obtained at

each tapping being forty-five pounds. In India the process of drying is performed naturally by the sun, and hence the lighter colour of the rubber.

Previous to the discovery of the *Ficus elastica*, the principal supply of rubber from the East was obtained from the *Urceola elastica,* which belongs to the family *Apocynaceæ,* and is found in the Malay Peninsula, Sumatra, and Java. It is a thick trailing vine, sending out roots from every joint and climbing the trunks of trees.

The amount of caoutchouc contained in the original milk varies considerably from many causes, such as the time of year, age of the tree, &c., but the average quantity obtained is 45 per cent.

Chemically, caoutchouc is a blend of hydro-carbons. Faraday's analysis showed a percentage of 87·2 carbon and 12·8 hydrogen, the formula being $C_4 H_7$. The composition, however, varies in different samples. Its specific gravity is about 0·93, and its properties are elasticity, imperviousness to water, alcohols, acids and alkalies; and last but not least, non-conduction of electricity. It is, however, permeable to gases, the following table representing the velocities of various gases through it.

Nitrogen	1·000	Marsh gas ...	2·148
Carbonic oxide ...	1·113	Oxygen ...	2·556
Air	1·149	Hydrogen ...	5·500
Carbonic Acid	13·585		

It is soluble in benzol, coal tar, naphtha, bisulphide of carbon, chloroform, oil of turpentine and other oils.

Now as to its preparation for commercial use, I intend to deal only with that section of the various processes which is involved in its preparation for electrical purposes.

A very valuable property of Indiarubber and one which has been a great deal made use of in the manufacturing processes, is that of adhesion between two freshly cut surfaces.

The earliest experimental treatment of this substance was made by Mr. Hancock who endeavoured to avail himself of the last mentioned property. His apparatus consisted of a small hand mill or hollow wooden drum in which was revolved a cylinder of the same meterial. The exterior surface of the latter and the interior of the drum were fitted with spike separators and sharp cutting edges. This had the effect when charged with rubber between the two cylinders and the inner one revolved, of cutting up the crude natural lumps of rubber into fine shreds, which, however, reunited and formed one homogeneous mass.

This crude invention eventually led to the adoption of the "mastication" process, as it is called, for the primary preparation of the rubber. By this process the rubber is freed from the impurities imparted to it by the natives during collection,

and is fashioned into large oblong blocks, six feet in length, twelve to thirteen inches in width, and seven inches thick.

There is some considerable heat evolved in the process, and the rubber so treated is in consequence more subject to atmospheric influence after treatment.

After passing through the process of mastication the rubber has next to be purified, and this is effected by cutting it up into very small slices, and stirring it together in warm water in order to wash out the dirt and impurities. After the first bath it is dried by spreading it on an iron plate heated by means of steam. It is turned over from time to time whilst on this plate, in order to get rid of any adhering particles, and is then again subjected to the washing process, this time being passed between two rollers under water. These various cleansing processes are then repeated until the resulting water shows no sign of impurities.

Having been finally washed and dried, it is next subjected to the tender mercies of a kneading machine. This consists of a horizontal cylinder pierced by a shaft carrying a few rows or transverse cars which rotate against a series of fixed teeth with sharp chisel edges. This machine has the effect of expelling any moisture or air which may be retained in the pores, and also of kneading up the rubber into a homogeneous mass. The rubber, during the kneading process, is usually passed through a series of these machines, the last of which sometimes consists merely of a shaft revolving in a corrugated cylinder.

The rubber is then subjected to hydraulic pressure, and is thereby converted into blocks. With this substance the maximum pressure exerted during the process is maintained until the rubber cools, when it retains its form.

From the blocks thus made it is cut into sheets and strips as occasion requires The cutting may be effected in various ways. One mechanical device consists of a straight steel blade, which is caused to vibrate rapidly to and fro in a horizontal plane, the rubber block being advanced to it by a leading screw in a similar manner to the slide rest of a lathe. The cutting edge is lubricated by a continuous jet of cold water which is directed on to it.

We have, however, in the electrical profession, to deal more especially with what is known as vulcanized rubber and ebonite, and I will, therefore, pass on to a description of the processes involved in its manufacture.

Vulcanization, in the true sense of the term, consists in combining sulphur with the rubber, whereby its sphere of usefulness is greatly extended. The process was discovered and patented in 1843 by Mr. Hancock, and consisted in fusing a quantity of sulphur in an iron vessel and immersing the pure rubber in the sulphur until it reached saturation point. The

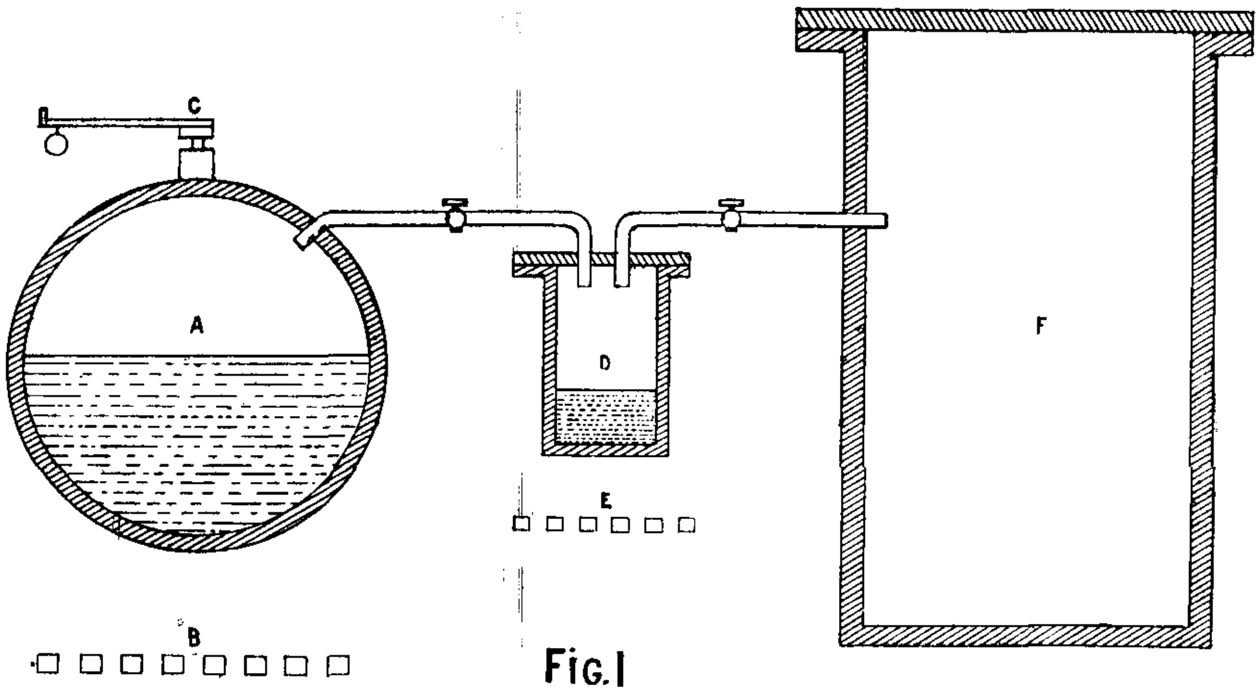

FIG. I

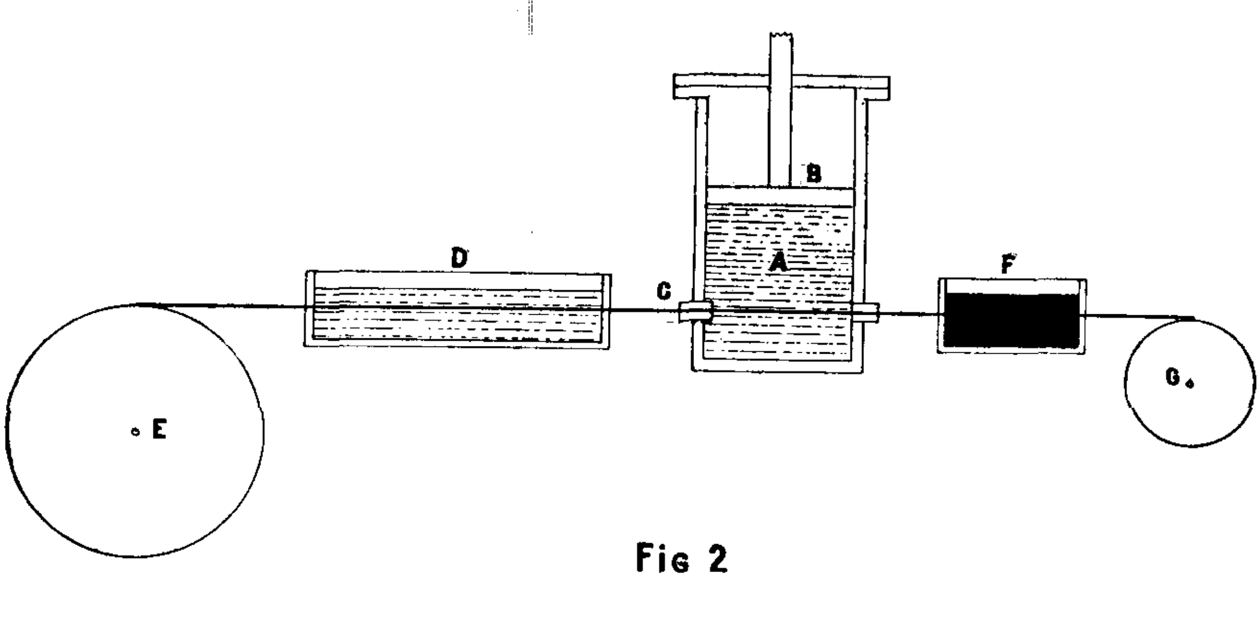

Fig 2

American ebonite :—

Rubber	...	... 12	parts by weight.
Sulpher	...	... 8	,, ,, ,,
Whiting	...	... 1	part ,, ,,
Wash	...	... 1	,, ,, ,,

Soft vulcanized Indiarubber :—

Para Rubber	...	... 7·5	parts ,, ,,
Sulphur	...	... ·75	,, ,, ,,
Lime ...	...	... ·01	part , ,,
Whiting	...	... 7·5	parts ,, ,,
French Chalk	...	... 1·25	,, ,, ,,
Litharge	...	... 1·5	,, ,, ,,

We now come to the second part of the subject, viz., the consideration of guttapercha. This substance was simultaneously introduced into Europe by Dr. Montgomery, and Messrs D'Almeida and Sons, of Singapore, in 1843. It is, like rubber, the inspissated juice of a tree, *Isonandra Gutta*, which is found in Singapore, the Malay Peninsula, and all the principal islands of the Eastern Archipelago. It belongs to the family *Sapotaceæ*, and grows to a height of seventy feet. The diameter of the trunk, unlike that of the rubber-bearing trees, is large in proportion being sometimes six feet. The wood of the tree is of *a soft and spongy nature and marked longitudinally at a point* just below the bark by black lines which indicate the channels containing the juice.

On its first introduction when the demand was urgent, the plan (a very wasteful one) adopted by the natives for its collection was as follows: The trees were cut down at the root, and circular channels or incisions were made round the bark of the trunk at distances of from twelve to eighteen inches apart. From these, the juice exuded and was collected in any handy vessels such as the shells of cocoanuts. After an exposure of a few minutes in this manner, the juice commenced to coagulate and was then collected by hand and kneaded into lumps. The amount collected from each tree, in this manner, averaged fiifteen pounds. The milk, however, is now obtained from incisions made in the bark of living trees and is kneaded into lumps as previously described. In some districts where the supply is large it is conveyed in bamboos to what is known as the "boiling house" where any aqueous portion is driven off by heat.

Its composition is similar to that of caoutchouc. It is a hydrocarbon containing about 90 per cent. of carbon and 10 per cent. of hydrogen. As imported, however, it contains many impurities, such as soft resin, vegetable fibre, ash, and moisture and is purified by extraction, the crude mass being dissolved in a suitable solvent, the guttapercha may then be precipitated by the

addition of alcohol, under the influence of which it forms as a milk-white deposit.

In its physical properties it much resumbles caoutchouc. It is soluble in bisulphide of carbon and choloroform, and also with the aid of gentle heat in benzol and oil of turpentine. A peculiar property of guttapercha and one which debars it to a certain extent from use in positions exposed to atmospheric influences is that of oxidation. When exposed to the air for any length of time its outer surface becomes brittle and resinous.

An examination under the microscope shows a porous construction, and its specific gravity is about 0·97 probably from this cause. It is very pliable and softens with a rise of temperature; but, within certain limits, returns to its original condition on cooling.

On its reception by the manufacturers it is first subjected to the following purifying process. The lumps are sliced very fine by a revolving disc driven by machinery and carrying a series of knife edges arranged after the manner of blades in a plane. The thin slices so produced are then immersed in a tank of warm water and thoroughly stirred to dissipate the impurities laid bare by the slicer. The guttapercha floats on the surface of the water and the impurities fall to the bottom. Being now in a somewhat soft condition owing to the warmth of the water bath, it is next submitted to a machine known as the "teaser" which resembles, in principle, the masticator used for rubber. This is driven at a speed of 800 revolutions per minute, and has the effect of tearing the gnttapercha into shreds. The latter fall into another water bath and are again washed as before. They are then submitted to a warm bath to soften them, and are afterwards treated by a kneading machine which again resembles that used for caoutchouc and which has the effect of blending them into a homegeneous mass. The guttapercha thus treated is then ready for use.

The method of applying it as an insulating covering to electric cables and wires is illustrated diagramatically in Figure 2 where A is a cylinder containing the molten guttapercha, and heated by a steam jacket not shown in the figure; B is a piston used to exert a pressure on the guttapercha in A; C is a die through the centre of which passes the wire or strand to be covered, and through which, on all sides of the core, the molten guttapercha is forced by the piston; D is a long trough of cold water through which the covered wire passes in order to cool the percha and render it firm before reaching the drum E on which it is wound; F is a tank of hot Chatterton's compound, which is applied before the guttapercha; and G is the drum of bare wire which has to be coated.

The material is also worked up in the form of sheets by passing it between sets of long steel rollers adjusted to the required gauge.

Guttapercha, like India rubber, may be vulcanised by the addition of sulphur.

Being in such universal demand it is somewhat expensive, and inferior qualities have been obtained from the Balatta tree which is indigenous to British Guiana, and may be tapped every two months, and also from a tree found along the line of the Western Ghauts.

J. WRIGHT.

In "Indian and Eastern Engineer."

January 1898.

The Camphor Tree.

An account of the range, cultivation, uses and products of the camphor tree (*Cinnamomum Camphora*) is given in a circular No. 12 just distributed by the United States Department of Agriculture division of botany and is thus commented upon by "Nature." Notwithstanding the comparatively narrow limits of its natural environment the camphor tree grows well in cultivation under widely different conditions. It has become abundantly naturalized in Madagascar. It flourishes at Buenos Ayres. It thrives in Egypt, in the Canary Islands, in south-eastern France and the San Joaquin Valley in California where the summers are hot and dry.

Large trees, at least two hundred years old, are growing in the temple courts at Tokyo, where they are subject to a winter of seventy to eighty nights of frost, with an occasional minimum temperature as low as 12° to 16° Fah. The conditions for really successful cultivation appear to be a minimum winter temperature not below 20° Fah. 50 inches or more of rain during the warm growing season, and an abundance of plant food, rich in nitrogen. In the native forests in Formosa, Fukien and Japan, camphor is distilled almost exclusively from the wood of the trunks, roots and larger branches. The work is performed by hand labour, and the methods employed seem rather crude.

The camphor trees are felled, and the trunk, larger limbs, and sometimes the roots are cut into chips, which are placed in a wooden tub about forty inches high and twenty inches in diameter at the base, tapering towards the top like an old fashioned churn. The tub has a tight fitting cover, which may be removed to put in the chips. A bamboo tube extends from near the top of the tub into the condenser. This consists of two wooden tubs of different sizes, the larger one right side up, kept about two-thirds full of water from a continuous stream which runs

out of a hole in one side. The smaller one is inverted with its edges below the water, forming an air-tight chamber. This air chamber is kept cool by the water falling on the top and running down over the sides. The upper part of the air chamber is sometimes filled with clean rice straw, on which the camphor crystallizes, while the oil drips down and collects on the surface of the water. In some cases the camphor and oil are allowed to collect together on the surface of the water, and are afterwards separated by filtration through rice straw or by pressure. About twelve hours are required for distilling a tubful by this method. Then the chips are removed and dried for use in the furnace, and a new charge is put in. At the same time, the camphor and oil are removed from the condenser. By this method twenty to forty pounds of chips are required for one pound of crude camphor.—

Scientific American.

A Forestry School in America.

We read in the "Forester," the American Forest Journal hitherto published and edited by Mr. John Gifford, of Princeton, New Jersey, and now taken over by the American Forestry Association, whose Head-quarters are at Washington, that a School of Forestry will shortly be opened at Biltmore, North Carolina, by Mr. C. A. Schenck, the Superintendent of the Forestry Department in that State. At the School, practical and theoretical instruction will be given to those who want to take up Forestry as a profession.

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Teak Plantations.

I send the following remarks on teak plantations for whatever they may be worth:—

1.—I have seen nearly *all the* yas in the Ataran valley in Tenassarim, (over 300). They are certainly most successful from a sylvicultural point-of-view, in fact rather too sucessful to pay well. It is a fact that many of the teak are growing in too moist places, and the immature wood is soft and soon decays, but we cannot yet say whether the quality will improve or not as the trees mature.

2.—It is also a fact that some of the trees get too much light and flower at an early age, but it cannot be laid down that such trees will not, *in the end*, make good marketable timber. I doubt if trees grown by selection clearings, and subjected to frequent fires, will turn out better than the average ya-grown tree.

3.—If there are to be no yas and no fires in the reserves, there will be very little teak reproduction in the moister forests of Tenasserim. There are very few seedling trees up to 5 or 6 years old in the fire-protected area of the reserves. The difference between the fire-lines and the area outside, on the one hand, and the so-called protected area on the other, is highly instructive. The best reproduction I have seen was on the fire-lines round the Kyunchoung Reserve. Again, in the north of the Dali Reserves, while the reproduction was poor inside the fire-lines, over exactly similar ground adjoining on the outside it was all that could be desired as far as numbers went.

4.—If we have fire protection in very moist forests, we must have plantations in some form. There is no doubt that yas are expensive, but with improved methods these expenses might, I think, be much reduced. It must be borne in mind that whatever store of luck awaits us with natural regeneration, the ya system, by making small areas with relatively large outer boundaries, scattered far away from other teak areas, will even-

tually considerably increase the spreading borders of the teak area, and must proportionately increase the natural regeneration.

5.—One of the chief reasons why yas have been so expensive is, that a very large number of plants per acre are grown and tended. This number in Ataran was 2,420. Formerly, the trees had been planted in various ways, in lines at various distances apart; latterly they were planted in lines only 6 feet apart, with the trees 3 feet apart in the lines. The result of this is to make the creeper-cutting very expensive.

6.—Unless the lines are very far apart (25 feet or so), the bamboo and weed-clearing would not, however, be proportionately decreased by reducing the number of trees, to say, 800 or 1,000, as it would still be necessary to cut away almost everything for the first three years. But if we are content with only twice the number of heathy trees per acre that one ever gets by natural regeneration, in other words, ten times the number got on the average, we can make the yas far less expensive than they are now.

7.—An acre will not hold more than 40 to 50 large teak trees. By starting with trees in pairs, each pair ten yards apart, and the trees in each pair about a yard apart, and then cutting away the worst tree in each pair in a year or two, there would be about 49 trees per acre left. The reduction in weeding expenses would be very great, and there would besides be a good mixture of bamboos, etc., between the teak trees. I believe it to be everywhere acknowledged that there ought to be a good undergrowth of bamboos, etc., if teak is not mixed with other trees. As matters stand at present, it is not fair to compare the relative cost of natural regeneration with that of yas, because not only are yas far more successful, but a large part of their expenses are incurred in carefully weeding trees that will never be required, and in cutting away these very trees a few years afterwards.

8.—As it is, the number of failures on suitable ground is not often 50%, and it is only reasonable to suppose that if the cultivators were given a smaller number of trees to grow, they would do them better. We want to produce, as cheaply as possible, 50 trees to the acre, and what the object of growing 2,420 is, I fail to see. As a matter of fact, some of the yas in Ataran which were considered so bad that the cultivators were not paid for them, are now excellent mixed teak forest, which we should be more than satisfied with had they been produced by natural regeneration. The trees in these "bad yas" are particularly healthy.

9.—It may be observed in conclusion that the teak is a very bad nurse tree, and teak should never be planted thick, as we plant the Scotch pine in Europe, to force up the main shoots and kill off the side branches. It gives no shade in the

hot weather. When grown thick the young trees crowd and injure each other without succeeding in thinning themselves out properly. *The ordinary bamboo and self-sown soft wood trees* afford the proper shelter for the young teak, and I have never seen a case in Ataran where there was any lack of this growth.

C. M. HODGSON.

The Cluster-pine in South Africa.

Additional remarks to "Pine Wood at the Cape." See January Number p. 38.

Nestling at the base of the last high range of mountains in the South-West corner of South Africa lies the Genadendal Mission Station at an elevation of only 840 feet above the sea. East and West stretches the Zonder-End range of mountains, towering upwards to 5,000 feet elevation and capped with snow at intervals during the winter.

Genadendal is one of the oldest Mission Stations in South Africa. First founded in 1737, it was abandoned in consequence of the opposition of the Dutch Government in 1745. In 1792 it was re-founded in spite of the opposition of the neighbouring farmers who naturally did not look with favour on the establishment of a large coloured settlement in their midst. The Genadendal Mission folk are half-bred Hottentots and descendants of liberated slaves. They number to-day 3,000 souls and cultivate 1,200 garden lots on the rich alluvial (vley) ground of the locality.

The Moravian Church is known to many Indian readers, their simple earnest worship; their government by Bishops similar to the Anglican Church; their pushing the missionary idea even to the subordination of the duties of father, mother and those human instincts that sway most of us. The Moravian is chiefly a missionary church. They have missions in every part of the world; and the members of their missionary community far surpass in numbers the members of their little home community in Saxony with its branches in England and America. It will be remembered that the original Moravian Church in Austria was extirpated, but that some of the refugees gathered together in Saxony during the thirty years war and there founded the new Moravian Church that has flourished since. Their missionaries are well trained practical men. And surely none of them ever conceived a happier idea than that of planting the Cluster-pine in this remote corner of South Africa. The rainfall is about 35 inches, falling almost entirely in winter. The mean temperature

60° Fah.; the climate generally that of Southern Europe, somewhat softened, *i. e.*, less brusque ; summers being cooler and winters warmer. Cluster-pine is grown largely in the Cape Peninsula and neighbourhood, but usually in small private woods that are cut over young for firewood. When not clean-felled young their case is worse. The English prejudice in favour of open forest causes them to be excessively thinned. The result is timber that is short, badly shaped and full of knots. Timber also that is too quickly and unevenly grown : and so cuts up coarse and of an uneven texture, the centre rings, say, half an inch thick, while the outer rings may not exceed one-twentieth of an inch thick. Such timber has naturally a bad reputation for house-building. Too sappy and quick grown, it soon becomes worm-eaten, while its coarse and uneven texture causes it to warp and season badly.

The Cluster-pine of close, well-grown plantations is very different. It has long clean cylindrical stems, perfectly free from knots, and wood of a fine even texture that cuts up well and seasons satisfactorily. It is a sufficiently good wood, I have long maintained, for all ordinary house-building. Hence the value of the Genadendal demonstration.

My researches show that the difference in the timber acre-increment between close and open Cluster-pine forest is small but very differently distributed. In the close forest the acre-increment is spread in thin paper-like layers round a large number of stems : while in open forest the acre-increment is expended in thick layers round a few stems.

The poor quality of the Gascony Cluster-pine timber is doubtless largely due to its being grown in forest, purposely maintained too open, in order to increase the production of resin. That good Cluster-pine timber can be produced in Gascony we see in the Biarritz Club and a few other buildings that are constructed almost entirely of Cluster-pine.

D. E. HUTCHINS, F. R. MET. SOC.

Insects attacking teak in Southern India.

The teak plantations of Southern India, at Nelambur, in Cochin and in Travancore, are liable to the attacks of one or more species of caterpillars which from time to time swarm over the trees in immense numbers, and consume their leaves, thereby doing a very great deal of harm. With a view to ascertain the species of moth or butterfly whose caterpillar was so destructive, and to learn something of the life-history of the insect, one

of our Rangers, Mr. V. K. Govinda Menon, who was trained at the Poona College of Science in the Forest Branch, was deputed last year to study the subject. His report, which has just been submitted, is, in spite of a certain quaintness of language, so instructive and interesting that I send a copy of it to you in case you should care to reproduce any portion of it in your Magazine :—

I have obtained the following additional information from the Ranger and others.

The attacks generally begin in April when the teak tree has put on its new foliage, and they last for about six weeks, when the caterpillars begin to disappear; but one or two may always be found on the teak if a search be made for them. The wet weather probably prevents the moth from increasing, and very little is seen of it until September or October, when, if the N.-E. Monsoon is light, its caterpillar may again attack the teak, the attack lasting about a month. Both very wet and very dry weather seem detrimental to the spread of the insect.

When the caterpillar begins to pupate it suspends itself by threads at either end to a leaf, not necessarily a dead leaf, spins a cocoon round itself, and folds the leaf over so that it is quite snug.

The caterpillar will eat the leaves of some jungle plants as well as teak, and it has been found in the jungle.

I am thankful to say that the caterpillar has an enemy in the shape of a fly which apparently lays its eggs in it, in which case the caterpillar remains inert and, after a time, some 20 or 30 minute flies appear.

The Ranger thinks that more than one species of caterpillar attack the teak, and he will be deputed to study the subject further when the caterpillars begin to appear. Certainly, the species that is the most common and has done the most damage hitherto is the black-headed grey caterpillar here described.

I forgot to say that the caterpillar, when it has once begun feeding, never leaves the tree, though it may shift from branch to branch when its food is exhausted in one place. It does not drop by a thread to the ground when it wishes to change its skin and therefore the system of tarring the stem of the trees, employed in Germany to prevent the caterpillars re-ascending them, is inapplicable.

T. F. BOURDILLON.

The life-history of the Insects which attacked the Teak Plantations at Perunthode.

In the months of September and October these plantations suffered severely from the injurious attack of a kind of beetle.

The larvæ of the beetle were found feeding on the leaves of the young trees in sufficiently large quentities to quite defoliate them all. From observations made on these insects and by watching the different stages of their growth, it has been possible to make out the following life-history of the moths.

The eggs of the moths are very small in size, have a yellowish white colour and are semi-transparent. They are generally laid on the under surfaces of the tender leaves and the young larvæ hatch out from these and begin to feed, in their first stage, only on the epidermis of the leaves in consequence of their mandibles not being fully developed; but in the course of 2 or 3 days they attain the power of eating away the whole leaf. In this way they continue feeding for about a week, when a change of skin takes place. Just a few hours before the change the larva stops feeding and lies in a state of semi-stupor. When the time approaches it makes some jerks with the body, fastening the prolegs firmly on the ribs of a leaf or on some such other convenient object. Instantly, the new insect protrudes itself through the head, throwing off the old skin. Immediately after the change of skin the colour of the head is pale-yellow, and that of the body pale-grey; but within an hour or so the head turns quite jet black. It then goes on eating the leaves again for 3 or 4 days, when a second change of skin takes place similar to the first. Again the feeding is continued for another 3 or 4 days when it becomes comatose preparatory to its chrysalis stage. It remains in its comatose condition for a day, during which time it is engaged in constructing its cocoon. After the third change of skin which takes place inside the cocoon the insect appears in its chrysalis state in which form it lies for about 8 days, after which the moth emerges. As soon as the moth comes out of the chrysalis it excretes a drop or two of a muddy coloured liquid matter which within a few minutes solidifies and turns quite white.

The moth is about half an inch long and measures one inch in width with its outstretched wings. It has two pairs of wings; an inner and an outer pair. The inner one is coloured orange yellow and black, while the outer one is of a greyish colour. They are very smooth and dusty. It has 3 pairs of legs on the breast, the front pair being a little smaller than the two lower ones. The head is pointed, with two small projecting eyes, and two style-like hairs about a quarter of an inch in length, standing erect upon the top of the head.

The length of the larva after the first change of skin is about a quarter of an inch. After the second change of skin it measures a little over half an inch, and in its fully developed state it is an inch and a quarter long and a little less than a quarter of an inch in breadth. The body of the larva is com-

posed of segments, 5 in the thoracic and 7 in the abdominal regions. It has six legs attached to the first three thoracic segments—two on each segment. The first four segments of the abdomen have each two small protrusions like glands on the underside—one on each side of the body of the larva. The last abdominal segment has two prolegs on its underside, which are used as legs when the larva walks. The body of the full grown larva is dark grey in colour. When the larva moves about, a pulsating motion can be distinctly observed, and when the insect is disturbed it emits a dark blue liquid from its mouth.

V. K. GOVINDA MENON,

Ranger.

III.—OFFICIAL PAPERS & INTELLIGENCE.

Forest Fires and their effects on the Reproduction of Teak.

It is desirable to remark, in the first place, that evergreen, tidal, and riparian forests need not be considered at all, as they are not subject to fires; that it is necessary to treat the question of fire-protection as regards its effects upon the soil itself, upon the reproduction and upon the existing growing stock; and that for the general discussion of the subject it is advisable to separate the deciduous forests into the three following classes :—

(*a*) Those in which the valuable species occur with a dense under-growth of evergreen, periodically and gregariously flowering bamboos, which more or less prevent natural reproduction of the tree-growth, except when the bamboos seed.

(*b*) Those in which the bamboo undergrowth possesses a lighter foliage and flowers sporadically as well as gregariously, and in which the reproduction of treegrowth can always take place, though more particularly at the time when the cover has been opened up by the general, but also sporadic, flowering of the bamboo.

(c) Those with an undergrowth of shrubs, herbaceous plants, and grasses only, and in which the valuable species are generally found as mixed forests, though occasionally, and more particularly in the case of cutch, growing in a pure state.

There is a general consensus of opinion that fire-protection does not actually result in the production of regular humus in any of the above classes of forests, but that nevertheless the condition of the soil is greatly benefited by protection and, on the other hand, its productive power is injuriously affected by constantly recurring fires. Where fire is common, the fallen leaves and other decaying vegetable matters are transformed into a layer of ashes which is blown away by the wind and washed away by the rains, so that the whole benefit to the soil is lost; and this is not all, for the torrential rain of the south-west monsoon also removes the top layer and most nutritive portion of the soil itself, so that in unprotected forests it is found that the small stones do not rest on the general level of the ground, but are supported by little pinnacles of earth, left when the surrounding exposed soil was washed away. There can, however, be little or no doubt that in fire-protected forests, the manuring principles of the decaying vegetable substances are returned to the soil, not in the usual form of humus, but more indirectly through the fæces and decomposing bodies of the myriads of earth-worms, ants, beetles, and other insects which consume such forest debris as fallen stems, dead wood, and leaves, and after extracting their requisite nourishment from it, emit the fæces, not in the form of more or less altered organic matter, but as a very fine, pure and fertile loam. It is true that this product also is liable to be washed away by the rain, but where fire-protection is successful the covering of dead leaves—and this is more particularly the case in forests of class (a)—lasts long enough to prevent the washing away of the surface soil before the live cover has re-established itself. The fact that fire-protection greatly benefits the soil is then beyond question.

In forests of class (a), protection from fire, or the occurrence of fire, can have no direct influence on the actual reproduction of trees, except during, and for some years after the flowering of the bamboos. It is possible then that a fire, occurring just when the culms begin to dry and before the bamboo seed has germinated, might be beneficial to the reproduction, but the cost to the growing-stock would be practically incalculable, and it is far from certain whether the fire, which would of necessity be a fierce one, might not very injuriously affect the seeding power of the mature trees during the critical period when reproduction can take place.

It is a fact that in forests of class (*b*), teak is better represented in areas subjected to fire than in protected forests, and that this is due to teak being more capable of withstanding, and to a certain extent of outgrowing, the effects of fire than any other tree. Nevertheless the effect of fires in forests of this class is most pernicious: for although we may obtain fewer teak seedlings in a fire-protected area, we know that these are healthier, grow faster and will yield better timber. We know also that by fire-protection we avoid constant injury to, and interference with, the development of the growing-stock while we prevent the steady deterioration of the soil.

Forests of class (*c*) are mainly important as cutch-producing areas and, as regards teak, are of no very great extent and are mainly confined to Upper Burma. The teak in them is chiefly produced in family groups, the formation of which can be encouraged and accomplished without the use of fires. The benefit conferred upon cutch-reproduction, by no other means than fire-protection, is a matter of common knowledge, and no further arguments are needed to prove the advisability of protection in forests of this character.

The majority of the officers consulted are then in favour of fire-protection, and the question may be summed up by saying that while protection in teak forests increases the fertility of the soil, and at any rate tends to increase the luxuriance and rate of growth of all classes of the growing-stock, and ensures an eventual yield of good and sound material, the constant occurrence of fire can only result in the gradual deterioration both of the soil and the growing-stock. Finally, it is possible to ensure the advantage gained in certain forests by the occurrence of fires, that is to say, the better representation of teak, by means of improvement fellings, but it is impossible to safeguard them from the damage caused by fires by any means other than fire-protection. (Review of Forest Administration in India in 1895-96, by B. Ribbentrop, C. I. E., Inspector-General of Forests).

V–SHIKAR AND TRAVEL.

After the Wily Boar.

The merry month of March is upon us, and the heat grows daily. Houses are filling in the hills, homeward-bound transports are crowded, and the feminine portion of Anglo-Indian society is *packing up*. Once more is the voice of the brain-fever bird heard in the land, its agonisingly reiterated three notes proclaiming that the hot weather is nigh. Yet there is joy in the heart of the sportsman—soldier, civilian, planter—all over the shimmering land, for "Dum Spiro Spearo," the thrilling delights of pig-sticking, and the tie for the Bulamabad Cup are at hand.

Not far from the high sandbanks which hem in the sacred river, in a Government-planted rectangular group of mango trees, gratefully breaking the endless expanse of emerald-green wheat crop and sun-baked plain, an indefatigable club secretary has *reared a cluster of white tabernacles. In the midst stands* the mess-tent; on the outskirts of the trees everybody's horses, tethered in lines with head and heel-ropes, a single blanket their manger by day, their covering at night, a bucket and brush their simple toilet requisites, and sleeping and eating by their side their two attendants with personal luggage of even a more elementary description. Very early on the eventful morning when the Cup is to be ridden for is the camp astir. Persevering and undaunted bearers have roused, dressed, booted and spurred their sahibs, who sit at the doors of their tents sipping the morning tea, without which in these degenerate days *no Anglo-Indian seems able to open his eyes. The sun* is not yet up, but the crows are. It must, indeed, be an early worm that can circumvent an average Indian crow. There is much shouting at and for servants, and some strong language going on in the tents. Tempers are not sweet at 7 a.m. Gradually everyone emerges, a motley crew, almost every class of European in India represented—full-blown Commissioners, on whom twenty years of the climate have had either a disintegrating or an enlarging effect; Colonels, noisy subalterns, rising "competition wallahs," and sporting police officers, with a detective's eye on a jug. *Neither is trade unrepresented, and a neighbouring* Rajah, who owns, and has entered some fine Arabs, comes on a marvellously caparisoned steed to view the sport.

The costumes are as varied as the riders. Some men go in for a turban, some for a mushroom pith hat, and some for a military helmet, with a curtain over the nape of the neck. Some men ride in their tweed and flannel coats, some in white drill or "karkee" cotton; some in merely a flannel shirt; while others are padded over the shoulders and down the spine, as a cricketer pads his legs, but to resist the sun. But one and all grasp a stout male bamboo, six feet six inches long, weighted with lead at the end, and tipped with a fine steel head. Not less various are the mounts. Smart little country or stud-breds, with, perhaps, queer tempers and man-eating propensities; languid-looking little stumbling Arabs, but warranted to look a charging boar in the face; grand, big walers, like English hunters, but, alas! not so staunch to pig as the Arabs.

After dinner the night before, the forty odd horses (it is the horses, not the riders, who enter for the Cup) have been drawn by lot into heats of four each, and now a general move of the competitors is made towards the home preserve, which is to be first drawn. It is a large patch of grass jungle, tall elephant grass, kept sacred for the Cup meet. The sportsmen draw off to the shelter of a native village on either side, and an army of native beaters and a long line of elephants are turned into the covert. Those of the first heat sit with tightened girths and lance in rest. The others bide their time with lighted cigar. To each party an umpire. Nearer and nearer through the jungle comes the roar of the beaters' cries on the fresh morning air. The tall grass waves where the elephants crash through it below, pea-fowl screech scared overhead, quail whirr by, startled black-buck bound frantically into the open plain, while ground game scuds away unheeded under the horses' feet. Suddenly a dark mass lollops quietly out of a corner of the jungle, and giving him a good start, the umpire shouts "Ride!" In an instant a waler, two Arabs, and a country-bred are after him. The first has the pace, and laying himself out at racing speed comes up first with the pig, "galumphing" awkwardly just ahead. He negotiates an eight-foot drain in his stride, and then after a long, straight run over the plain, "jinks" suddenly to the left, just as the waler has gained on him. But the Australian would not or could not turn quickly enough, and this lets an Arab in. The boar leads him over a castor-oil crop, ten feet high, which, taken externally, brings his rider to grief. The waler nicks in again and rattles piggy into a corn crop, but swerves just as his rider gets his spear down for a thrust. It is, of course, the first spear that counts.

Meantime, other pigs have broken covert, and other parties are dispatched after them. At a big meeting like this for the Cup, sows are frequently ridden, though this is not the case in everyday sport. One of the weaker sex, after leading her

pursuers over a strip of fallow and into a guava orchard, over an Irish on-and-off bank, where they nearly batter their brains out against the low branches, squats defiantly, and charges like a boar. One grey old fellow, a huge black mass, thirty-three inches at shoulder, with bristles erect, and murderous-looking tusks, bears down upon a waler, who swerves at the awesome sight, and his rider, determined not to lose the spear gets it indeed, but at the cost of several somersaults executed between a pig and a horse rapidly retiring in opposite directions. With a crash the Arab lands knee-deep in a water-hole, one of the few sources of promotion left in the country! Meanwhile, the boar, badly wounded, has set himself down under a thorn-tree, foaming at the mouth, and charging desperately, till someone is found with more pluck than discretion to dismount and give him his quietus by a lucky thrust between the shoulders.

The sun is now unpleasantly high in the heavens; the welcome "peg" elephant heaves in sight, and there follows an adjournment to camp for a mid-day halt and snooze. The final heats are run in the afternoon, till the sun is setting rapidly in a cadmium sky, and the short Indian twilight comes on. Then follows a merry feast in the mango grove, with a hoisting of the victor of the Cup round the mess-tent, disturbing the bewildered owls and flying foxes in the branches overhead, and a drowning with song and choruses the pariahs that bay round the village, and the howl of a distant jackal on the plain.—(*Globe, March 1897.*)

VI.—EXTRACTS, NOTES AND QUERIES.

Analysis of Indian Aconites.

The aconites are among the articles of minor forest produce of interest to Forest Officers in the Himalayas, so we reproduce from the Agricultural Ledger Series the following note by the Director of the Scientific Department at the Imperial Institute. The Bengal specimens were carefully collected by Mr. F. B. Manson.

"*Nepaul Aconite* (Aconitum ferox).—Five samples of roots have 'been examined, one from the Punjab, the other four from Bengal. 'With the exception of one of the latter specimens all these roots 'furnished a crystalline alkaloid which corresponded in every res'pect with the highly poisonous 'pseudaconitine' of which an 'account has been already published by Mr. F. H. Carr and myself '(*Journal of the Chemical Society, 1897*). A further description of 'the properties and physiological action of this alkaloid will 'shortly be communicated.

'A crystalline alkaloid was extracted from one specimen of 'roots, certain properties of which do not exactly correspond with 'those of pseudaconitine. If a further supply of these roots can 'be procured, I should like to examine this alkaloid more fully.

'The quantity of pseudaconitine contained in each sample has 'been estimated by a process which consisted in the extraction of 'the alkaloid and the separation from it by hydrolysis of the vera-'tric acid; by these means the following results were obtained :—

Name.	District.	Percentage of Alkaloid.
A. ferox	Bashahr through the Conservator of Forests, Panjab.	·40
A. ferox, *var.* crassicaulis ...	Through the Deputy Conservator of Forests, Darjiling, Bengal.	·41
A. ferox	Ditto ditto ...	·30
A. ferox, *var.* crassicaulis .	Ditto ditto ...	·50
A. ferox	Ditto ditto ..	·35

'These results are interesting in revealing a larger percentage 'of pseudaconitine than has hitherto been supposed to occur in the 'roots of this plant, in one case as much as half per cent. being 'present. These roots, therefore, contain a larger proportion of 'pseudaconitine than the roots of the closely allied *Aconitum 'Napellus* contain of aconitine.

'The investigations which are being conducted by the Scienti-'fic Department render it probable that Nepaul Aconite and its 'active alkaloid, pseudaconitine, will prove to be as valuable medi-'cinally as the *Aconitum Napellus* and its active alkaloid, aconitine, 'which are now almost exclusively employed in Europe. At pre-'sent there is no large demand for Nepaul Aconite in the English 'market, chiefly because of the uncertainty which has hitherto sur-'rounded the nature of its constituents and their precise medical 'action; even the exact source of Nepaul Aconite is not yet set-'tled; although the plant is usually regarded as *Aconitum ferox*, 'there is some reason for doubting whether this is the case. I 'hope that the attention of the Botanical Survey of India will be 'directed to this question,

'*Aconitum Napellus.*—The one sample of the roots of this 'plant came from Kaghan, Panjab. On examination the roots 'were found to contain the same constituent, aconitine, as the 'plant furnishes when grown in Europe. The proportion of this 'alkaloid in the present specimen is very small, and the sample 'compares unfavourably with the roots of European origin which 'appear in the English market."

I shall be glad to receive for examination specimens of the roots of these two plants from other districts of India, and also of the roots of any other species or varieties of aconite than those with which we have already been supplied.

A further report will shortly be made on the examination of the later series of aconite specimens received in June, 1897, including a preliminary account of the constituents of *Aconitum palmatum.*

Flower-Farming in India.

Considerable attention is now being paid to the cultivation of flowers for the manufacture of essential oils, especially in such countries as Victoria, where the climatic conditions are such as to make the industry a profitable one. In an article contributed to the *Indian Pharmacologist* (January, 1897), W. Lodian, C. E., recommends a more extensive cultivation of flowers in India, and considers it probable that, with the combined advantages of cheap labour and good climate, such an industry would be profitable in that country. At present, the great bulk of the essential oils used in Europe is obtained from the South of France, Italy, and the United States. The following prices are quoted by the author as the value, per acre, under cultivation, of some of the common flowers: bitter-orange blossom, £60 to £80; jasmin, £20 to £30; roses, £70 to £90; and peppermint £45. The author gives a short account of the methods usually adopted for the preparation of essential oils, such as the "enfleurage" process and extraction by methyl chloride, special attention being directed to points which are likely to be overlooked by a beginner. The farmer is also recommended to keep himself well acquainted with the extensive modern literature on the subject, in order to be able to take advantage of the various improvements suggested by experts from time to time.—(*Imperial Institute Journal*).

Distribution of Prizes and Certificates at the Imperial Forest School, Dehra Dun.

This annual ceremony took place at Dehra, on the 1st April, the Inspector-General of Forests presiding. He was supported

by the Director and Deputy Director and Instructors of the School, and by the members of the Board of Control, *viz.:* Mr. H. C. Hill, Mr. E. F. Elliott and Mr. A. Smythies, Conservators of Forests, with their Secretary, Mr. F. B. Bryant, Assistant Inspector-General. The proceedings were opened with the Director's Report of the year. He began by mentioning that his own acquaintance with the Class about to leave was very slight, as he had been away nearly the whole time, his place being occupied by Mr. J. W. Oliver; that the day's ceremony was the seventh that had taken place since the function was started; and that he owed his best thanks to the staff of the School and Forest Circle, as well as to others who, like Mr. Reynolds, Mr. Duthie and Mr. Collins, had assisted in the teaching and examinations.

The results of the examinations were not so good as in 1897, for in the Upper Class there were 8 failures out of 28, though the whole of the Lower Class (9) passed. Two students obtained Honours, bracketed equal; they were G. O. Coombs and D. A. Stracey. The other Upper Class passed students were J. P. Gregson, Govind Rao Sapre, C. Medworth, Lakshmi Sahai, Ashutosh Chackrabarty, L. S. Jones, H. C. Ross, Bhag Ram, B. K. Ukidwe, F.C. Purkis, Oung Ban, G. F. Matthews, S. C. Lee, C. A. Clerk, A. M. Handy, J. P. Nazareth, H. McL. Carson; and a sick certificate was given to J. W. Hamilton.

The Medals all went to Coombs, Stracey and Gregson; those of the Lower Class to Ram Saran and Maqbul Nabi Khan. The Prizes were won by Carson, Stracey, Coombs, Gregson, Janes, Ram Saran and Khemanand; some being for practical work, some for Notebooks, some for Herbaria and Entomological Collections, both of which were excellent, while the special prize for Athletics, given by Mr. Ribbentrop, went to Purkis. After some further general remarks, the Certificates, Medals and Prizes were distributed by Mrs. F. Beadon-Bryant, and then the Inspector-General began his address to the students in which he commented on the difficulty of the Examinations, the unfortunately large number of failures and other matters; and after complimenting the Director of the past year (Mr. Oliver) and the more permanent and present Director (Mr. Gamble) gave some good advice to the students about to leave. The proceedings concluded with lusty cheers for Mrs. Bryant, the Inspector-General, the Board of Control and Directors and Staff.

The day was unfortunately very hot, so that the number of visitors collected in the big tent was not so great as usual; still most of the residents of Dehra appeared, and among them were noticed especially Colonels Begbie (2nd P. W. O. Goorkhas) Strahan, R. E., and Gore, R. E.; Messrs. Streatfeild, Way and Bell, C. S.; Mr. R. Thompson, late Conservator, C. P., and the principal native gentlemen of Dehra.

Assimilation in Green Plants.

At a meeting of the Cambridge Philosophical Society, held on November 8th, 1897, the President, Mr. F. Darwin, made a communication on a method of demonstrating assimilation in green plants. Farmer has shown that the protoplasm ceases to circulate in an Elodea leaf subjected to a stream of hydrogen and kept in the dark; also that if the preparation is illuminated the circulation begins again. The cessation of the circulation depends on the protoplasm being deprived of oxygen, the reappearance of the movement is a consequence of the fresh supply of oxygen yielded by the chloroplasts in light. The experiment can be more simply performed by mounting in water two or three Elodea leaves under a single cover glass, and sealing the preparation with melted wax and paraffin. The leaves if kept in the dark, begin after a few hours to suffer for want of oxygen, and after six or seven hours the protoplasm ceases to circulate The movement may be restored by exposing the preparations in sunlight or to incandescent gas flame. Thus, a demonstration. in its way as interesting as Engelmann's bacterial method may be very simply performed.—(*Nature.*)

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The oldest India-rubber Plantation in the World.

(*Translation.*)

The oldest Caoutchouc plantation in the world is perhaps one existing in the west of Java, in the province of Kranong. A former proprietor of the Pamanockan Tjiassan Estate which is the biggest private property in Java, containing 540,000 Dutch acres, had most of his land under coffee until 1872. Finding the cultivation of this plant was no longer lucrative, he planted some of the land up with *Ficus elastica*. The coffee plantations had already been more or less cleared of forest growth, so that the planting of *Ficus elastica* cost less than thirty shillings per acre. The soil of these coffee gardens had become useless for other agricultural purposes; and had not *Ficus elastica* (Karet) been planted in time, would only have become covered with poor forest growth. The trees were planted 8¼ yards apart, or 72 trees to the acre. The area planted was 72½ acres, containing 5,200 stems. The trees were first tapped when the plantation was 14 years old, and the yield for that and the six following years was :—

Year.	lbs.	Average-oz. per stem.	Value.
1886	5,512	17	£ 600
1887	4,954	15	,, 540
1888	1,514	4	,, 165
1890	3,307	10	,,* 360
1891	6,113	18	,, 387
1892	5,992	18	,, 256
1895	3,197	10	,, 411
Total	30,589	Average per year per stem 6 ozs.	£2,719

* This note is taken from a report of the Netherland Indian Commercial Bank, in which the money results are called "net income," presumably after deducting the original cost of the planting operations.

72½ acres thus, it is said, yielded in 7 years a surplus of £2,719, or per acre per annum £5-8-0. The yield was 71 lbs. per acre per annum during this period. During the 23 years from the establishment of the plantation in 1872 till 1875 the net yield per acre per annum amounted to £1-12-10,

WAGENINGEN, HOLLAND :	A. H. BERKHOUT,
6th January 1898.	*Late Consr. of Java Forests.*

The bark of Cleistanthus Collinus as a fish poison.

In the "Indian Forester" for June 1896, Mr. W. F. Biscoe drew attention to the economic uses of the *kodarsi* tree in the Nizam's Dominions. *Kodarsi* (Telugu) and *Oduran* (Tamil) are the vernacular names of the *Cleistanthus collinus, Benth*, which was formerly known as *Lebidieropsis orbicularis, Mull.-Arg.* It was stated that the tree is largely used, and has a valuable timber, which, in its pole stage, is considered as good as teak.

On the authority of Dr. Ainslie and Dr. Roxburgh the fruit of this tree is reported to be exceedingly poisonous, one pagoda weight of the capsule in powder is believed to be sufficient to kill a man. The leaves and roots are also harmful, and the first is avoided by animals. The chemical examiner of Madras within the past twelve years has been in a position to confirm these reports, and has discovered the leaves and fruits of the tree being employed for criminal purposes in South Arcot, South Canara, Malabar and other districts in the Presidency. Mr. Biscoe, in the extract above referred to, specifies the deleterious properties of the bark. He writes: "The bark must contain some poisonous property, for not only do white ants leave it severely alone, but it is used here for poisoning fish. The inner bark placed on the sores of sheep and goats is efficacious in healing them and in destroying maggots."

Wishing to examine the bark of *Cleistanthus* with the object of detecting the active principle, Mr. Biscoe obligingly sent me a parcel of a few pounds of the freshly dried bark, together with some of the capsules, for chemical analysis. The bark was in the form of thick incurved pieces, of a reddish brown colour, with a dark brown exterior. The powder was of a light-red colour, having an astringent taste, but destitute of any marked odour.

The amounts of moisture and mineral matter were estimated in a small sample of the powdered bark, and another portion was

treated to the successive action of different solvents which revealed the following approximate composition :—

Moisture	6·70
Fat, &c. (ether extract)	·78
Spirit extract	32·42
Water extract	7·86
Pectin, &c., by difference ...	2·45
Crude fibre	42·44
Ash	7·35
Total ...	100·00

The fatty matter removed by ether possessed no peculiar reactions, and as usual, was associated with chlorophyll. The spirit extract was of a fine red colour, and left a brittle residue when evaporated down to dryness ; it consisted almost entirely of tannin. Duplicate estimations of the amount of tannin in the original bark gave an average of 33·3 per cent., a quantity much above that found in ordinary tanning barks. An examination of the various extracts revealed no distinct evidence of such principles as alkaloids or glucosides, and it seems conclusive that the activity of the bark resides in the astringent substance.

Those who have studied the subject of fish poisons will have noticed the wide range of vegetable products used in this connection. *Kaka-mari*, the berries of *Anamirta Cocculus*; bark of *Walsura Piscidia* ; the fresh bark of various leguminous plants, as *Tephrosia*, *Derris*, *Mundulea*, *Erythrina* ; the pungent flower-heads of *Spilanthes* ; the fruits of species of *Randia* ; and the barks of Euphorbiaceous trees as *Flueggia*, *Macaranga* and *Securinega*. Some of the last-named are characterised as being rich in tannin.

Fish seem to be particularly sensitive to substances of an acrid, bitter or astringent nature. Plants containing the soap-like principle, called saponin, are, without exception, fatal to fish life. The toxicity of tannic acid or tannin does not seem to have been noticed by previous observers, but its occurrence in plants used for destroying fish in which more active principles are absent, leave grounds for supposing that this widely distributed plant constituent is harmful.

A few preliminary experiments have been made by mixing in pure water, containing live fish, a few grains of commercially pure tannic acid. The experiments have shown that the acid has a decidedly toxic action on small fish. From the movements of the fish it was evident that the acid was a most objectionable addition to the water, but whether the tannin itself killed them, or, by abstracting oxygen from the water, indirectly produced suffocation, must be left to physiologists to decide.

CALCUTTA : }
16th April 1898. }

D. HOOPER.

Note on the Working-Plan for the Nilambur Valley Teak Plantations.

1. The plan for the Nilambur plantations has been prepared with great care by an officer whose theoretical and practical knowledge of forestry is fully evidenced on every page of his excellent report, and has, after due scrutiny, received the sanction of the Madras Government. It is therefore with considerable diffidence that I venture to submit remarks on the work, and to offer a few suggestions which occur to me after an inspection of the Nilambur plantations.

2. Mr. Lushington has rendered excellent service by the compilation of a clear and succinct history of the creation of the plantation, not merely in regard to the working-plan under

notice, but in connection with the treatment generally of one of our most important forest trees in India. Reading this history, the practical forester is at once struck with the great divergence of opinions expressed by the several officers, who inspected the plantations from time to time, opinions varying from the most optimistic to an almost entire condemnation of the scheme. An examination of the area cultivated, as it exists at present, offers, however, to my mind a sufficient explanation of the difference in the opinions recorded.

3. The soil varies greatly: some portions consist of a deep, rich, and at the same time, well-drained alluvium; in others it is composed of ridges on which the laterite is exposed to the day. Between those two extremes, the one the most favourable imaginable, the other entirely useless, for the growth of teak, soils of every degree of suitability are found.

As regards the earliest plantations they were, as a rule, confined to the alluvial stretches, and consequently show excellent results, but later on the selection of the areas was less scrupulously attended to, and the newer plantations contain considerable areas which should never have been entirely cleared of the original forest growth and exposed, and even if this had been done, should most certainly not have been planted with teak. It is undeniable that even on soils of this class good teak trees are sometimes found interspersed in the natural forest, but such have established themselves on spots selected by nature and have grown under conditions entirely different from those existing on a regular plantation.

4. The great differences existing in the several portions of the plantations have decided Mr. Lushington to separate the present growth into two classes and blanks. Whenever I have had the opportunity of examining his classification between the first and second class, I convinced myself of the correctness of his separation, but I am impressed with the fact that his second class forests contain now and then considerable areas which do not come up to the standard adopted by him for that class, and which might with advantage be placed in a lower category. This, however, is a question which may stand over till the working-plan is revised on a future occasion. The admirable history compiled of former operations, and the picture we have before us on the ground, however, clearly indicate our action with regard to the future extensions of the plantations. I do not think it will be necessary to confine our operations entirely to the limited areas which will grow first class forests, but we must fix a point, as regards the physical qualities of the soil, beyond which teak-planting should not be extended. We have ample means of doing so, for though during the first few years of the life of a teak plantation and immediately after the natural forest has been removed, the growth of the young plants does not indicate the unsuitability of the soil to the same extent as in after

life, the fact remains that before the plantations have reached an age of ten years the surface soil or laterite deteriorates owing to complete exposure during a large part of the year, and the growth of the plants shows a constantly increasing want of vigour. I would suggest, therefore, that the soils in plantations ten years of age and over should be carefully classed in accordance with their physical qualities, especially as to depth, and the degree of intermixture with laterite nodules, and that it be ascertained under what conditions of soil a serious lagging behind in the growth in height of the teak trees commences. Once this is ascertained no teak-planting operations whatsoever should take place on soils of such or a worse character. It would be advisable to make this classification of soils in advance of planting operations and prepare a soil map of the areas which are still available for extension of the plantation. I am in favour of excluding in future even the smallest unsuitable areas. The interspersion in the teak area of plots of natural forest of a different character can only be beneficial, whereas, on the other hand, an unhealthy teak forest, grown on unsuitable soil, must always be a source of danger, for it is in such forests that insects and fungi make their first appearance. This is by no means pure theory, but is borne out by practical observations in Burma.

5. It may, in this connection, perhaps, even become a question for consideration whether it would not be advisable to cut down some of the most inferior teak stock and to replant the areas with *Xylia dolabriformis*, mahogany and other soil-improving species in mixture. Fairly extensive experiments have been made from time to time with the introduction and cultivation of mahogany, and I observe from Mr. Lushington's working-plan that he recommends not merely the abandonment of these efforts, but the removal of the existing trees. This has already been effected in 24 acres in Ramalur, * and the same procedure is proposed in regard to a fourth area in Aravillykava † in 1900. In my opinion this decision is, to say the least, premature. Mahogany has never had a fair chance at Nilambur, and has been, sylviculturally, wrongly employed and treated from the outset. The unavoidable failure of any attempt to mix trees so entirely antagonistic in their characteristics as teak and mahogany of the same age, should have been foreseen. The existence of survivors of mahogany in spite of this proves the vitality and recuperative power of the tree under the climatic conditions which the Nilambur forests offer. The trees of the *Swietenia Mahogani* species in the Aravillykava block are no doubt poor specimens, but they look fairly healthy now, and owing to the many vicissitudes of their early life, have a gnarled appearance

* See page 69 of the working-plan, Chapter V, paragraph 3 (2).

† See pages 68 and 69 of the working-plan, Chapter V, paragraph 3 (1).

and should produce finely figured and valuable timber. If the block in which these trees grow is to come under the axe in 1900 in order to make room for a pure teak plantation, I hope they will be spared and placed under more favourable conditions of growth by the removal of trees overhead.

6. In this connection I would also point out that though it may be advisable to remove the Ceara, the necessity for the extraction of healthy teak trees in vigorous growth does not seem clear. The desire to create uniformity of age in the several blocks is too pronounced, and but thinly covers the desire to utilize some larger trees for the sake of the immediate revenue. I am inclined to doubt whether for some years the areas will show the full power of production of teak. They have been under this tree and Ceara for many years and have deteriorated, not merely owing to the characteristics of these trees, but to the treatment which was in vogue of clearing the forests of all undergrowth and bushes.

7. If it be decided to carry on further experiments with mahogany, which I feel inclined to recommend, I would suggest that the trees may be planted in small groups, either pure or in intermixture with more suitable companions, such as *Xylia dolabriformis*, *Pterocarpus Marsupium* and others, and that these small areas may be fenced. Trees planted under unsuitable conditions and together with entirely uncongenial companions are exposed to dangers, such as borers and sambur, which may not threaten them to the same degree under more favourable circumstances.

I would not even entirely condemn the *Swietenia Mahogani* in favour of its near relative the *macrophylla*. It is true, the latter has shown greater vigour when in company with teak, chiefly, however, in localities less suitable for the latter species, but there is not sufficient proof that the *Swietenia Mahogani* will not, under more favourable circumstances, prove a success as well. However, even *macrophylla* timber commands a higher price than teak, and it is a matter of great importance that it is not necessary to plant either of the Swietenias on the best teak soil; both species are much less exacting in this respect than the teak tree and improve the soil, whereas the latter impoverishes it to a great extent, especially where the forest is kept free of undergrowth, as in Nilambur. This clearance is a great mistake and opposed to all rational principles of sylviculture. The practice was evidently introduced by Mr. Ferguson, who had been trained in Scotch plantations, but survived his reign until quite recently.

8. With regard to thinning, I am aware opinions very greatly differ; but I am personally convinced that as a rule it has been somewhat too severe, and that many of the small side branches which have formed low down on the stem of the majority of the teak trees, and which may more or less affect the

future value of the timber, are to a great extent due to this fact. The crown development cannot follow the too rapid disturbance of the canopy, and side lights cause the formation of side branches. These branchlets exist to a much less degree in a neighbouring private plantation which was never systematically thinned, but in which the dominant trees have nevertheless distinctly declared themselves. This is a matter I would recommend for further study, as the correct sylvicultural treatment in this respect is as yet by no means finally settled. The prescriptions regarding thinning operations are somewhat too uniform. The operations should follow the conditions of each class of forest, and should vary, both as regards time and severity, in forests created on different soils. This has frequently been overlooked in the past, and the fact that the material is so easily saleable at a considerable profit has, I am afraid, in many instances led to thinning out of trees which it was not sylviculturally necessary to remove. However, I do not think that any permanent harm has yet been done anywhere, and if the crowns in the older plantations are now allowed to reclose overhead, and undergrowth is encouraged instead of removed, it is probable that the side branchlets mentioned above will disappear without leaving any permanent flaws in the timber.

9. The age of exploitability, which Colonel Beddome placed from 60 to 80 years, has probably been more correctly estimated by Mr. Lushington, who, very wisely leaves the future treatment and reproduction of the forest to be settled and decided upon by future generations of foresters. The forecast of the final yield and of financial results made by Mr. Lushington is probably somewhat sanguine, but it will stand a considerable reduction and still show a profit which cannot be realized from the land in any other way. The past history of the plantation has proved that the operations repay the outlay thereon at an early age, and the capital value stored up in the forests created, guarantees an exceedingly fine net income for the future, several times as large as could be obtained from good paddy land under permanent cultivation. The chief reason for this is the favourable situation of the Nilambur plantation as regards export, which makes the value of the material *in situ* at least twice as much as in any other locality known to me.

10. Under such conditions I think it is false economy to restrict annual extension to 80 acres, as proposed in the last clause of Appendix D on page 38 of the working-plan; for, in my opinion, it will be easy to prevent over-crowding the market with saplings, even if thinnings be carried out over more extensive areas, for the thinnings can, in accordance with the demands of the market and with benefit to the forest of the future, be made lighter than has hitherto been the practice.

11. My advice is therefore to extend the annual planting operations over as large an area of the suitable soil available as

means will permit, but I beg to reiterate that I consider the previous selection of the areas to be planted a *sine quâ non*, and I would therefore recommend the early preparation of a detailed soil map. It would not seem necessary that such a map should be mathematically accurate, for all that is required is that the areas selected for planting should be easily recognisable on the ground, that a forecast should be possible of the areas available, and that the extensions should be made in accordance with a preconsidered plan. The art of planting teak successfully has, in the course of years, been thoroughly acquired, so that even if the area planted annually were trebled or quadrupled, no great increase in supervision would seem to be demanded. To what extent the manual labour required to increase the annual outturn in planting operations is available is a question that must be decided locally.

The objections made by Colonel Beddome against the greatest possible extension of the Nilambur teak plantation, recorded in paragraph 27 of its history, are not sound. There is no reason why the naturally grown mountainous teak forests should be neglected, but they will never repay an outlay of money to the same extent as the Nilambur plantation. The physical qualities of teak grown on rich well-drained alluvium, are always superior to those of the more slow growing mountain trees. This has been once more proved to be true, for the outturn of the 24 acres in the Ramalur block has been pronounced of the very best quality by the Calicut trade and has been paid for accordingly. Finally, there is no fear that the few thousand acres over which the Nilambur teak plantation can be extended will glut the teak market of the world.

12. It would appear that the experiments carried out with the introduction of rubber-yielding trees have so far been unsuccessful, but I feel nevertheless disinclined to agree in the proposal that the experiments of making the Nilambur Basin an important centre of rubber supply should be discontinued. I agree, as in the case of mahogany, that the areas most suitable for teak plantations should not, as a rule, be utilised for this purpose, but it would appear to me that in the first instance the tapping operations, mentioned on page 36 of the working-plan, were not carried out with sufficient care, the produce being much mixed with dirt, and that though the Ceara may ultimately be found to be unsuitable, this is no proof that other rubber-yielding trees will be equally so. To me it seems that the Nilambur basin is eminently adapted for the growth of rubber-yielding plants, and the facility of export renders the prospect of a trade in a product which can bear a land transport of hundreds of miles particularly attractive. The demand for rubber, and its price, are constantly increasing, and I would strongly advise that experiments should be continued till the most suitable rubber-yielding tree is found, which will grow in localities not required for extension of the teak plantation.

The country at the foot of the Nilgheries seems to be eminently adapted for the growth of *Ficus elastica*, and I beg to recommend that the introduction of this tree in these localities, as well as in the Nilambur plantation, which may have been classed as teak-producing, may be experimented with. The seed of the tree and a memorandum on its cultivation may be obtained from Assam. I may perhaps mention that both in Assam and Egypt this tree is now being cultivated by private enterprise.

B. RIBBENTROP.

V-SHIKAR AND TRAVEL.

VI.-EXTRACTS, NOTES AND QUERIES.

Artificial Indin Rubber.

One of the most recent important events in the history of chemistry was the discovery by an English professor that a substance corresponding in every respect to India rubber may be produced from oil of turpentine.

Dr. W. A. Tilden, Professor of Chemistry, in Mason College, Birmingham, began a series of experiments with a liquid hydrocarbon substance, known to chemists as isoprene, which was primarily discovered and named by Greville Williams, a well-known English chemist, some years ago, as a product of the destructive distillation of India rubber. In 1884, says *The New York Sun*, Dr. Tilden discovered that an identical substance was among the more volatile compounds obtained by the action of moderate heat upon oil of turpentine and other vegetable oils, such as rape-seed oil, linseed oil and castor oil.

Isoprene is a very volatile liquid, boiling at a temperature of about 36 degrees Fahrenheit. Chemical analysis shows it to be composed of carbon and hydrogen in the proportions of five to eight.

In the course of his experiments Dr. Tilden found that when isoprene is brought into contact with strong acids, such as aqueous hydrochloric acid, for example, it is converted into a tough elastic solid, which is, to all appearances, true India rubber.

Specimens of isoprene were made from several vegetable oils in the course of Dr. Tilden's work on those compounds. He preserved several of them and stowed the bottles containing them away upon an unused shelf in his laboratory.

After some months had elapsed he was surprised at finding the contents of the bottles containing the substance derived from the turpentine entirely changed in appearance. In place of a limpid, colourless liquid, the bottles contained a dense syrup, in

which were floating several large masses of a solid yellowish colour ; upon examination this turned out to be India rubber.

This is the first instance on record of the spontaneous change of isoprene into India rubber. According to the Doctor's hypothesis, this spontaneous change can only be accounted for by supposing that a small quantity of acetic or formic acid had been produced by the oxidizing action of the air, and that the presence of this compound had been the means of transforming the rest.

Upon inserting the ordinary chemical test paper, the liquid was found to be slightly acid. It yielded a small portion of unchanged isoprene.

The artificial India rubber found floating in the liquid, upon analysis showed all the constituents of natural rubber. Like the *latter, it consisted of two substances, one of which was more soluable* in benzine or in carbon bisulphine than the other. A solution of the artificial rubber in benzine left, on evaportion, a residue which agreed in all characteristics with the residuum of the best Para rubber similarly dissolved and evaporated.

The artificial rubber was found to unite with natural rubber in the same way as two pieces of ordinary pure rubber, forming a a tough, elaslic compound.

Although the discovery is very interesting from a chemical point of view, it has not as yet any commercial importance It is from such beginnings as these, however, that cheap chemical substitues for many natural products have been developed. Few persons outside of those directly connected with rubber industries realize the vast quantities imported yearly into this country. Last year there were brought into United States ports, as shown by the reports of the customs officers, no less than 34,348,000 pounds of India rubber. The industry has been steadily progressive since the invention of machinery for manufacturing it into the various articles of everyday use. The wonderful growth of the India rubber interest in this country will be seen from the statistics compiled in the tenth census.

In 1870 there were imported 5,122,000 pounds at an average rate of $1 per pound, in 1880 the imports were 17,835,000 pounds at an average price of 85 cents per pound, in 1890 31,949,000 pounds were imported at an average price of 75 cents per pound.

The present price of India rubber varies from 75 cents per pound for fine Para rubber to 45 cents per pound for the cheapest grade.

It will be seem that, notwithstanding the increase in importations, the price of the raw material remains at a comparatively high figure. Many experiments have been made to find a substance possessing the same properties as India rubber, but which could be produced at a cheaper rate.

Many of the compositions which have been invented have been well adapted for use for certain purposes, and have been used to

adulterate the pure rubber, but no substance has been produced which could even approach India rubber in several of its important characteristics. There has never been a substance yet recommended as a substitute for rubber which possessed *the extraordinary elasticity which makes it indispensable in the* manufacture of so many articles of common use.

Great hopes were at one time placed in a product prepared from linseed oil. It was found that a material could be produced from it which would, to a certain extent, equal India rubber compositions in elasticity and toughness.

It was argued that linseed oil varnish, when correctly prepared, should be clear and dry in a few hours into a transparent, glossy mass of great tenacity. By changing the mode of preparing linseed oil varnish, in so far as to boil the oil until it became a very thick fluid and spun threads, when it was taken from the boiler, a mass was obtained which, in drying, assumed a character resembling that of glue.

Resin was added to the mass while hot, in a quantity depending upon the product designed to be made, and requiring a greater or less degree of elasticity.

Many other recipes have been advocated at different times to make a product resembling caoutchouc out of linseed oil in combination with other substances, but all have failed to give satisfaction, save as an adulterant to pure rubber.

Among the best compounds in use in rubber factories at present is one made by boiling linseed oil to the consistency of thick glue. Unbleached shellac and a small quantity of lampblack is then stirred in. The mass is boiled and stirred until thoroughly mixed. It is then placed in flat vessels exposed to the air to congeal.

When still warm the blocks formed in the flat vessels are passed between rollers to mix it as closely as possible. This compound was asserted by its inventor to be a perfect sustitute *for caoutchouc.*

It was also stated that it could be vulcanized. This was found to be an error, however. The compound, upon the addition of from 15 to 25 per cent. of pure rubber, may be vulcanized and used as a substitute for vulcanized rubber.

Compounds of coal tar, asphalt, &c., with caoutchouc have been frequently tested, but they can only be used for very inferior goods.

The need for a substitute for gutta percha is even more acute than for artificial India rubber. A compound used in its *stead for many purposes* is known as French gutta percha. This possesses nearly all the properties of gutta percha.

It may be frequently used for the same purposes and has the advantage of not cracking when exposed to the air.

Its inventors claimed that it was a perfect substitute for India rubber and gutta percha, fully as elastic and tough, and

not susceptible to injury from great pressure or high temperature.

The composition of this ambitious substance is as follows :—One part, by weight, of equal parts of wood tar oil and coal tar oil, or of the latter alone, is heated for several hours at a temperature of from 252 to 270 degrees Fahrenheit, with two parts, by weight, of hemp oil, until the mass can be drawn into thread. Then one-half part, by weight, of linseed oil, thickened by boiling, is added. To each 100 parts of the compound, one-twentieth to one-tenth part of ozokerite and the same quantity of spermaceti are added.

The entire mixture is then again heated to 252 degrees Fahrenheit and one-fifteenth to one-twelfth part of sulphur is added. The substance thus obtained, upon cooling, is worked up in a similar manner to natural India rubber. It has not been succesfully used, however, without the addition of a quantity of *pure rubber to give it the requisite elasticity.*

A substitute for gutta percha is obtained by boiling the bark of the birch tree, especially the outer part, in water, over an open fire. This produces a black fluid mass, which quickly becomes solid and compact upon exposure to air.

Each gutta percha and India rubber factory has a formula of it own for making up substances as nearly identical with the natural product as possible, which are used to adulterate the rubber and gutta percha used in the factory. No one has as yet, however, succeeded in discovering a perfect substitute for either rubber or gutta percha.

The history of chemistry contains many instances where natural products have been supplanted by artificial compounds possessing the same properties and characteristics. One of the most notable of those is the substance known as alizarine, the colouring matter extracted from the madder root. This, like India rubber, is a hydrocarbon.

Prior to 1869 all calico-printing was done with the colouring matter derived from the madder root, and its cultivation was a leading industry in the eastern and southern portions of Europe.

In 1869 alizarine was successfully produced from the refuse coal tar of gas works and the calico-printing business was revolutionized.

The essence of vanilla, made from the vanilla bean, and used as a flavouring extract, has been supplanted by the substance christened vanilla by chemists, which possesses the same characteristics and is made from sawdust.

Isoprene, from which Dr. Tilden produced India rubber, is comparatively a new product, as derived from oil of turpentine.

It yet remains to be seen whether rubber can be synthetically produced certainly and cheaply. The results of further experiments will be awaited with interest, as the production of artificial rubber at moderate cost would be an event of enormous importance.

—(*Scientific American.*(

The Larch.

By W. R. Fisher.

It is extremely important to encourage the cultivation of larch in Britain, owing to the excellent quality of its timber and the rapidity with which it grows, but planters have of late been discouraged by the prevalence of the fatal larch-canker. In the present paper, therefore, a description will *first* be given of the conditions for a vigorous growth of larch in its native forests, and, *secondly*, an attempt will be made to explain how the knowledge of these conditions may be applied to its cultivation in Britain, so as to secure for it, as far as possible, immunity from disease. For the former, * "Gayer's Treatise on Sylviculture," by the eminent Professor of Forestry at Munich, and the † *Flore Forestière*, by A. Mathieu, late Professor of Natural History at Nancy, have been consulted, and for the latter, the writer has been chiefly guided by ‡ "Michie's "Treatise on the Larch," and by his own personal experience in English and Welsh woodlands.

(*a*) Geographical Distribution.

The true home of the larch is restricted to the Alps, the Carpathians, and a few parts of the mountainous region of North Moravia. Here—but especially in the central chain of the Alps, more on their southern than on their northern slopes and to the east of the Bavarian Alps—the larch forms nearly pure woods and produces the finest timber. In such places the larch spreads as naturally as the oak in Sussex, and if any meadows near the larch-woods are not regularly mown, young seedlings of larch spring up everywhere in them. Under the mature larch an excellent crop of grass is produced, sufficient on about $2\frac{1}{2}$ acres of woodland to feed a small Alpine cow during the summer, the grazing being as valuable as the wood.

In most other Alpine regions, spruce, beech, Cembran pine or silver fir are mixed with larch in larger or smaller proportions, but it is rare to find the larch completely absent, except in certain districts of the Alps, on limestone rock. There are also splendid crops of larch in upper Silesia and in the district of Glatz. With the spruce and Cembran pine the larch ascends in altitude to 7,500 feet, the limit of tree vegetation, but does not extend nearly so far north as the spruce, and clearly, demands a greater supply of heat than the latter tree. On the northern declivity of the Alps the larch descends to the valleys, but not below 3,500 feet on their southern slopes. It thrives better in the lower portion of its zone than above 4,000 feet. Wilkomm—the first investigator of the

* Der Waldbau von Dr. Karl Gayer, 3rd edition, Berlin, 1889.

† "Flore Forestière," par A. Mathieu, 3rd edition, revised by P. Fliche, Paris, 1897.

‡ Published by Blackwood & Co., 1885.

larch-canker, named after him *Dasyscypha* (*Peziza*) *Wilkommii*—states that the amount of heat required by the larch corresponds to a mean annual temperature between 30° and 46° Fah.

A very short spring, a uniformly and moderately warm summer, and a long winter's rest, which should last at least four months, and during which the larch appears to be quite indifferent to extreme cold, are apparently required. The larch is extremely resistent to heavy snowfall, being leafless in winter, and its branches are strongly joined to the stem and highly elastic, so that the wind readily shakes off any snow which may rest on them. Although in its native forests the larch can withstand strong winds, yet it grows best in sheltered valleys and ravines. It is therefore clear—and Gayer insists strongly on this fact—that the larch does not require dry breezy situations, but prefers damp air, although this to a certain extent favours the canker. Hence, in the *high mountains, it avoids northerly and north-easterly aspects,* when these are exposed to dry continental gales.

(*b*) Soil Requirements.

The larch is not particular as to the mineral character of the soil, provided the latter is sufficiently friable, moist, but well drained and deep. It resembles the Scotch pine in preferring deep soil, and though on rocky ground its roots spread far in search of clefts, through which they may pass down into the sub-soil, yet it never succeeds on very shallow soil. The larch also requires the soil to be sufficiently loose for its roots to penetrate to some depth, but not so loose as to become easily dried up in hot summers ; it never thrives on gravels, which drain the soil of its moisture. The best larch trees in the Alps occur in localities where the surface of the ground is strewn with blocks of stone and boulders, between which the roots can penetrate and obtain plenty of moisture and mineral matter, as in the ravines and bases of slopes in the Engadine. The larch requires less moisture in the soil than the spruce, but more than the Scotch pine ; it *prefers soils which remain* fairly moist throughout the year, and can withstand excess of moisture in the ground better than a scarcity of it.

The annual shedding of the larch needles supplies the soil richly with humus, and it is probably due to this fact that the tree will grow on soils which are comparatively poor in mineral nutriment. Frank* has shown that conifers have a symbiotic growth with certain fungi which cover their roots and thus enable them to obtain nitrogenous compounds from the air contained in the soil, another reason why very compact soils do not produce good trees. This symbiotic growth is possible only in soils containing sufficient humus, in which trees have two kinds of roots, the larger ones penetrating into clefts of the

* Ber. d. deutsch, botan, Ges. 1892, p. 583.

rocks and into the sub-soil, and obtaining water and mineral matter by means of root-hairs, and also affording stability to the tree against storms, while the rootlets in the humus layer, which may be termed surface-feeders, afford the nitrogenous and other nourishment so important for vigorous growth, and which is taken up by the fungus around them.

As regards its demands on mineral matter in soils, the larch is more exacting than the spruce or Scotch pine, and thrives better on loams or marls, than on poor sands and calcareous soils. Doubtless the preference for a little clay in the soil is due to the fact that clay retains moisture; a richness in humus is always a good substitute for clay in this respect.

(c) Light Requirements.

No tree requires more light than larch, which thus resembles the birch. Its rapid upward growth soon enables it to get its head free from surrounding vegetation, and it cannot withstand overcrowding, either of its crown or its roots. In the Alps, the mature larch are grown with their crowns absolutely free from neighbouring trees, for, when crowded, their crowns are small and confined to the top of the trees, and their boles are merely slender poles. The larch, like the spruce, preserves its leading shoot for a long period, and under favourable circumstances, attains a height of over 100 feet, and Mathieu cites cases of a larch tree 160 feet high in Canton Valais, and another 175 feet in Silesia.

(d) External Dangers.

Although a few beetles (*Hylobius notatus, Tomicus typographus* and *T. laricis*) attack the cambium of the larch, yet, in its native region, they do not effect any serious damage, but certain lepidopterous larvæ, such as those of *Tortrix pinicolana* and the leaf-miner, *Coleophora laricella*, destroy the needles, and so do certain sawflies, *Nematus laricis* and *N. Erichsoni*, whilst the larch-aphis (*Chermes laricis*), covered with a white woolly down, which makes affected larch trees appear as if sprinkled with snow, eats the needles in the middle, giving them a peculiar elbowed appearance. None of these insects, however, are so dangerous to the larch as when it is cultivated outside its mountain home. As already stated, larch is not liable to serious damage by snow nor by rime-frost, whilst owing to the fact that the roots of the trees are kept cold by the snow till May and that the warm weather then comes on rapidly, the buds form their foliage late and rapidly and are seldom endangered by spring frosts. Owing to its rapid growth when young, and its power of reforming an injured leader, the larch speedily recovers from injuries by game or cattle, especially as the former are not plentiful in the Alps.

The larch, in its mountain home, is a fairly storm-firm tree, though, as already stated, it prefers sheltered positions to those exposed to cutting dry winds. Even the destructive canker is not often fatal to it in the Alps, as this fungus generally forms fertile spores only in low damp situations near the lakes, or on low branches of saplings, smothered by a dense growth of herbage. The fact that the fertile spores can infect the trees only through wounds also renders the disease rare in the Alps, as wounds are rare, and the larch in its native home is in a thoroughly healthy condition.

(*e*) Quality of Timber.

Mountain grown larch affords one of the strongest and most durable of European timbers. It is formed of narrow-zoned alternate layers of softer spring-wood and harder summer-wood, is saturated with resin and very tough and elastic. The sapwood, composed of ; to 20 zones, is rarely more than half an inch wide, especially in old trees, which increase very slowly in diameter, whilst the heartwood is reddish-brown with alternating zones of lighter coloured spring-wood and darker summer-wood, and contains numerous large resin canals. Its specific gravity may be as high as 0·83, corresponding to a weight of 52 lbs. per cubic foot. Mountain larch-wood is fully equal in strength and durability to the best oakwood, and is also split into staves and roofing shingles.

II. The Larch when Cultivated in Britain.

Owing to the preference of the larch for damp air, it thrives in the insular climate of Britain much better than in the drier atmosphere of North Germany, this preference for damp air being clearly shewn by the occurrence of fine larch near the sea-coast in Oldenburg. The West of France, on the other hand, is too warm for larch, which grows there rapidly enough in its youth, but soon falls off in vigour, while its timber only weighs about half as much as good mountain larchwood.

Michie states that larch thrives better in the North than in the South of Scotland, the reverse being the case for England, but the reason he assigns for this is incorrect, as he says that the soil is drier and the atmosphere contains less moisture in the North of Scotland and in the South of England than in the intermediate region. One of the finest Welsh larchwoods the writer has ever seen is in Lord Powis' estate, near Lake Vyrnwy, and here the rainfall is 60 inches, and the atmosphere generally very moist, the soil being a deep moist loam. Michie himself refers to the excellent growth of larch in the North of Ireland, where the atmosphere is surely damper than in the North of England. Any one who may doubt whether a moist atmosphere and damp soil suit the larch should visit the neighbourhood of Virginia Water and Windsor Forest, where some of the finest mature larch trees

in Britain may be seen, and several healthy young larch plantations, whilst other plantations on shallow soil and dry aspects are ruined by the canker. In Britain, the successful cultivation of larch depends more on a suitable choice of soil and aspect and on proper treatment than on the state of the atmosphere, which in the British Isles is always moist enough for the production of fertile spores of the fungus. In fact, according to Webster, larch-canker first appeared in the drier and more easterly parts of England, and is rare in Ireland, in spite of its very moist atmosphere. When larch is planted in localities where spring frosts are severe, where the foliage comes out early, or where owing to a soil too compact, loose, or shallow, or too dry an aspect, its growth is languishing, or where it is injured by game or insects, or the crop is too crowded and the trees have insufficient room for their crowns or roots, it is always liable to disease.

The canker, according to Michie, attacks only parts of trees under 15 years old, so that in a tree growing 18 inches a year and 22½ feet high when 15 years old, the lowest 18 inches is proof against disease, and every year an additional 18 inches is safe. Hence, when the tree is 30 years old and 45 feet high, the lower 22½ feet is disease-proof. The canker is also much less hurtful on the crown and branches of trees over 20 feet in height than on younger trees, and the crowns of older trees are less liable to infection than the bases of saplings.

Excellent larch timber is produced in Britain, and the tops of the trees may be used as posts and rails, which last four times as long as those of Scotch pine. On the Tay and elsewhere, it is extensively used for ship-building, and for rural purposes it is admirably adapted for all outdoor fabrics exposed to wind and weather. It is therefore not surprising that many millions of larch trees have been planted in the British Isles, and although its cultivation has of late been checked by the ravages of the canker, there is no doubt that attention to the conditions for growing healthy larch will enable landowners still to plant it on a large scale.

A fairly complete account of the fungus causing larch-canker is given by the present writer in Vol. 4 of "Schlich's Manual of Forestry;" but, in 1895, when the book was published, he was not aware that it is not always correct to follow Hartig's advice and restrict larch plantations to breezy hill-sides, as the fungus can produce fertile spores anywhere in Britain. Colonel Pearson, formerly Conservator of Forests in India, who now resides at Kingston-Downton, in Herefordshire, near some extensive larch plantations, was the first, as far as the writer knows, to observe that larch is freest from canker when grown on northerly aspects, and the present writer has seen perfectly healthy crops of larch on northerly slopes bordering Lake Vyrnwy, in Wales, whilst on the other side of the same hills, facing the south and west, the

larch plantations are completely ruined by canker. There is a plantation of larch on a deep moist loamy soil, on the northern slope of Coopers Hill, the trees being nine years old and already over 20 feet in height and absolutely free from canker, whilst on the flat land on the Bagshot sands, in an estate only two miles off, the larch suffers greatly from canker, although on northerly aspects in the same estate quite healthy and vigorous larch trees are growing. A damper situation cannot well be found than that of the Coopers Hill plantation, facing, as it does, the Thames Valley and frequently enveloped in fog, whilst the sun's rays hardly reach it, owing to the northerly exposure. The reason for the vigorous growth of larch there, and on northern aspects generally, seems to be that the soil remains moist throughout the year, whilst the slope prevents the moisture from stagnating in the soil and rendering it sour. The feet of the trees are also kept cool in the spring, and thus they are restrained from early sprouting and consequent damage by spring frosts. On southerly and westerly aspects, on the contrary, the hill-sides are dried by the sun's rays, and the plants are tormented by the strong south-westerly gales; their growth is thus rendered poor, and they are injured by the wind and by spring frost, which does more damage by rapid thaw on warm aspects than by the actual cold produced.

Michie cites many fine larch trees growing at Dunkeld and other places in Scotland on northerly aspects, and says that the north side of a hill is best adapted to grow larch to age and large dimensions, while on the south it grows more readily when newly planted and comes sooner to maturity. The writer's experience in Wales, however, leads him to recommend the avoidance of all southerly aspects for larch, and de Candolle, when applied to in 1833, by the Editor of the *Quarterly Journal of Agriculture*, stated that in Switzerland, in valleys parallel to the equator, all the side facing north is frequently covered with larch, while there are none at all to the south.

This is no contradiction to the statement already made that larch grows best on southerly aspects in the Alps, for it is a general fact, noted in "Schlich's Manual of Forestry," Vol. I, p. 114, that trees which on high mountains grow best on southerly aspects come round to northerly aspects lower down.

Michie says that poor superficial soil over a hard sub-stratum gives rise to root-rot in larch, which is termed *pumping*, and experience in the Windsor Forest shows that this disease always arises there, when larch is grown over gravel or iron-pan. In fact, gravelly sub-soil dries up the surface too much for this tree, besides being frequently impervious to its roots, and the same may be said of layers of flints above chalk when covered with only a thin layer of loam. According to both Michie and Webster, larch thrives on well-drained peat when not too compact;

but the former states that when peat-land has been for some time used as arable land and is then planted with larch, the trees become *pumped*.

Larch cannot stand exposure to strong westerly and south-westerly gales, and when so exposed the trees either lose their leaders or become bent like a sabre at the foot, while the crown bends away from the wind direction. Such trees, however, have a special value in Scotland as curved wood for building herring boats. The writer has seen all the trees in a larch plantation bent out of the vertical by the west wind. This plantation was on level ground which had been deeply trenched all over; but in a neighbouring plantation, where the larch had been pitted, the trees were vertical, having a stronger foothold.

From a consideration of the above remarks it appears that larch should not be planted in frost-holes, nor in localities exposed to strong gales. Soils should be selected which are sufficiently deep, moist and friable, to afford a vigorous growth. The plants used should be small and sturdy with well-formed roots, two-year-olds being most suitable, and they are better when taken from a home-nursery than when exposed to the risks of a long journey before planting: the idea, sometimes prevalent, that larch plants purchased from a nursery in the North of Britain are hardier than home-grown plants, is contrary to the writer's experience in the South of England. It appears from Michie's researches that good Scotch seed, or good seed from Switzerland and the Tyrol, gives equally good plants: the latter are, however, said to sprout earlier and consequently to be more tender during the first two years than plants raised from Scotch seed.

The plants should be pitted at distances of five feet apart, and it is probably better to plant pure larch, but beech and larch form a good mixture, and near Cooper's Hill, sweet chestnut and larch is a common crop, though these species would certainly thrive better apart, the chestnut suffering from overcrowding when young and the larch when over 30 years old. Michie says that mixing larch with other conifers in even-aged woods is prejudicial to the former tree.

Early, frequent and moderate thinnings should be carried out, only dead and suppressed stems being removed until the wood is 30 to 40 years old and grass appears under the trees. The dominant trees should then be isolated by the removal of all interior and cankered stems, and the wood under-planted with beech, silver-fir, or Weymouth pine, which will shelter the soil and keep up the necessary supply of humus. The writer cannot say whether the Alpine custom of combining pasture with larch cultivation by leaving the trees isolated and grazing down the grass, can be followed in Britain without too much deterioration of the soil. Michie says that the Athole larch forests are depastured by sheep, and that most of the soil is too wet for cattle, which leave foot-prints for water to stand in and injure the roots of the trees.

The above plan for growing larch trees should be followed if large timber is required, the trees being preserved until they have attained the desired dimensions, when either the underwood may be cut and natural regeneration of the larch obtained, or the whole crop felled and replanted with larch. In case only poles are required for pit-timber, or for posts or rails, there would generally be no object in under-planting; but the larch should be carried on to the age of 50 years, by successively thinning out suppressed trees, and then felled and replanted.

When larch is grown for hop-poles, as in Kent and Sussex, closer planting should be adopted from 18 inches by 18 inches, to 3 feet by 3 feet, according to the size of poles required. The whole crop may then be felled when about 15 to 20 years old, or half the trees felled when suitable for smaller poles, and the rest later on.

Outside its natural zone, larch suffers considerably from hares, rabbits and deer, and game must be kept down in larch-woods, or wire fences used until the trees are out of danger.

It will be seen that the writer advocates larch plantations in Britain only in localities thoroughly suited for the tree, and that they should be carefully treated and protected from damage; and though grown sufficiently close in their youth to afford tall and clean stems, that the older trees should be allowed plenty of room for crown and root expansion, and the soil protected from drying-up and impoverishment, by under-planting with shade-bearing trees.—*Land Magazine.*

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Conversion of a Sissu Forest into a Mulberry Forest through the Agency of birds.

The following note is an illustration of the important part played by birds in scattering seed, and of the way in which a forest of one species may be converted into a forest of a totally different species through their agency.

The particular bird I refer to is the rose coloured starling (*Pastor roseus*) or commonly known as the "Tillyer" in vernacular.

During the season of the ripening of the Mulberry fruit, end of March to end of April, these birds literally swarm in the Changa Manga Plantation, and can be seen in the early morning flying in dense flocks, sometimes in such numbers that the sky is darkened overhead and there is the sound of a strong wind blowing as they fly by.

These birds come to the plantation simply to feast on the mulberries, and leave again as soon as the fruit is over. Where they come from and where they disappear to, I do not know.

They settle on the tops of the trees in such numbers and so closely together, that the tree-tops look black with them.

It is undoubtedly these birds who spread the mulberry seed, and being in such large numbers, it is not difficult to understand how very large areas are sown up with seed in their droppings.

One day I happened to notice the birds particularly, sitting in swarms on the tops of the sissu standards in the area just felled on the coppice with standard system. The tree-tops were black with birds and they made a deafening noise. Before long they rose and settled a little further off and so they continued doing until the whole regeneration area must have been visited by them.

This sight was sufficient to explain, how it is that instead of getting the felled areas regenerated with sissu coppice, they are chiefly covered with a dense growth of mulberry.

The Changa Manga Plantation was originally practically pure sissu. It has just completed its first rotation, and the standing

crop instead of being pure sissu coppice, is more than half mulberry, some compartments with the exception of the sissu standards being pure mulberry.

The first coupe of the second rotation has just been felled and it was on the standards in this area that I noticed the birds in such swarms as just mentioned. and there is little doubt that the whole regeneration area has been sown with mulberry seed in the birds' droppings. Mulberry being a faster grower than sissu and a shade-bearer, the latter species has no chance against it and unless assisted artificially there is little doubt that the entire standing crop, with exception of the sissu standards, at the end of the second rotation will be pure mulberry if the two species are left to themselves, and this result will have been brought about almost entirely through the agency of these "Tillyers."

I may add however that it is is not intended to let the mulberry have all its own way, but sissu, as the more valuable species, will be assisted by cutting back and keeping the mulberry below it.

Provided the factors of locality are suitable, the method of treatment of these two species is undoubtedly two-storied high forest. It is not intended however to go into any sylvicultural questions beyond showing the part played by the "Tillyers" in introducing mulber y.

I enclose a photograph which I am afraid is rather poor but was taken under difficulties. It shows the Tillyers in fairly dense masses on one tree a little to the left of the centre of the photograph.

There are also a few birds away to the right. Unfortunately most of the birds flew away before I could expose the plate. The locality is a portion of coupe 1, just felled over, and the birds are on the standard trees.

B. O. C.

15th May 1897.

Note.—The photograph shows the birds excellently, but we regret that it is not quite suitable for reproduction.

Hon. Ed.

A Longicorn Beetle which attacks Mulberry Trees.

The Shahdera Reserve, a "Sailaba" plantation on the banks of the Ravi about five miles from Lahore is literally infested with this beetle, as evidenced by the number of attacked trees. The plantation consists of about equal parts of Shisham (*Dalbergia Sissoo*) and Mulberry (*Morus indica*) with a few trees of *Acacia arabica* and *A. modesta.* Of these only mulberry is attacked, its wood being fairly soft. Both small and large trees are attacked and on a large scale, whichever side one looks, numbers of trees can be seen with the characteristic rusty, red stain on their stems, caused by the trickling down of sap from the holes made at the surface by the larvae.

The presence of the larvae in these stems was noticed some time ago, and search was made for the mature beetle, but as far as I am aware without success until last year, when by regular searching, specimens of both pupa and mature beetle were found in larval burrows, thus leaving no doubt as to their identity. This was about the middle of July, and as no specimens of the mature beetle could be found in the burrows in August, that must be about the time they fly. The larvae can be found at all times of the year and of all sizes, clearly denoting that they take several years to become mature.

Specimens have been sent to the Calcutta museum, and the information obtained that the beetle is a *Cœlosterna* and probably *C. scabrata* which does damage to Sal in Oudh. This year it is hoped that more specimens will be obtained and the beetle be properly identified.

The larvae, commencing high up, burrow down the entire length of the stem and often a considerable way down one of the main roots. The burrow is confined entirely to the heartwood, except where the larva comes to the surface, making communication with the outside The Mature larva is half an inch across the head and so the burrow is no small one and causes great damage to the wood. After reaching its lowest limit the larva appears to hollow out a chamber sufficient to enable it to turn round, and then burrows straight up the stem again, sometimes following the old burrow, and sometimes striking a new one.

I have never come across more than one larva in the same stem and shall like to know whether this is a case of the survival of the fittest or whether one egg is deposited by the female beetle.

The mulberry is of little value as timber, and even as fuel is of poor quality. This being so, the damage is not of a very serious nature. It may be that in future it will be more valued as timber; for already there is a demand springing up for it for making tennis racquets and hockey sticks. Should this be so, then it will be necessary to take steps to get rid of the beetle.

The full sized larva is about 3 inches long and of the usual longicorn type. The mature beetle is $1\frac{1}{2}$ inches long in good specimens and is covered all over with a golden brown pubescence. Its elytra are rough especially near the thorax.

B. O. C.

How Rubber Trees (Ficus elastica) are grown in Assam.

BY D. P. COPELAND, DEPUTY CONSERVATOR OF FORESTS, DARRANG DIVISION.

Ficus elastica.

1. The India rubber fig or Caoutchouc tree is indigenous in Assam where it is found a dominant tree in the evergreen forests. It requires an exceedingly damp atmosphere, and the best natural rubber trees are met with in the forests at the foot of the hills, or on the hills themselves up to an elevation of 2,500 feet.

Natural germination.

2. In its natural state, the rubber starts from seed dropped by birds in the forks of other trees, often 20 or 30 feet or even more from the ground, where it germinates, and the young plant remains an epiphyte for years until its aerial roots touch the ground; as soon as this takes place, the little epiphyte changes rapidly into a vigorous tree, throwing out numerous aerial roots which gradually envelope the tree on which it first began life and often kill it out.

Having started life so high up, it soon throws out branches which overtop the surrounding trees, and the numerous aerial roots, which fall from these and establish connection with the

ground, in a few years enable it to dominate the forest growth around it.

Seed.

3. The seed of this tree is contained in fig-shaped fruit, about 75 seeds being found in one good sound fig. The fruit first begins to form on the trees in March and ripens from May onward to December. On some trees the whole crop ripens and falls off by June, but, as a rule, the rubber tree has fruit on it from April right up to December, the figs forming, ripening and falling off, the whole of the rains.

After collection the figs have to be carefully dried and mixed with pounded charcoal, which preserves the seed for several months.

Seed beds.

4. In the Charduar rubber plantation nursery, for a seed bed 40′ × $3\frac{1}{2}$′, two to three seers of pulverized rubber seed. 10 seers ash and 20 seers of vegetable loam or good soil, is well mixed in a half cask and spread evenly over the bed, and then lightly tamped down and watered Such a bed should yield, with good germination, 2,000 seedlings and should be sufficient for putting out 100 acres of rubber planted 70′ × 35′. The beds must be well-raised and drained, the soil being prepared in the same way as for vegetable or flower seed. If sown in boxes, these should be put under the eaves of a house; if in beds, light removable shades must be put up to keep off the direct rays of the sun. The shades should be removed during rainy or cloudy weather and at night.

Light sandy loam is most suitable for seed beds; if the soil is stiff, charcoal dust should be mixed with it to make it porous and prevent caking. The bed or boxes must never be allowed to get dry.

Sowing.

5. This should be done exactly in the same way as for vegetable or flower seed which requires transplanting after germination. The figs are broken between the hand. As the seed is very minute, the particles of the fruit are left with the seed and sown with it, no attempt being made to clean or separate the pulverized figs. In order to distribute these minute seeds evenly over the seed beds, or boxes, a certain quantity of ash and soil is mixed with them.

Germination.

6. Germination takes place from the end of April to the end of the rains. Seed sown between October and January, requires daily watering and screening from the sun, and will not germinate before the end of April or the beginning of May, but seed sown any time during the rains will germinate in a few days (from five days to a fortnight). It follows that the best time for sowing seed is during the rains—that is from June to September.

The embryo appears on the germination of the seed as a seedling having a pair of opposite cotyledons with an entire

margin destitute of incisions or appendage of any kind, with the exception of the notched or emarginate apex, oval in general outline, green in colour and of a glassy smoothness. The second pair of leaves shows a tendency to the alternate arrangement on the stem but appears at the same time. Their shape and venation are very different from those of the primary leaves for they have a central midrib and a distinctly coarsely-crenated margin. The third pair of leaves do not appear simultaneously, and are distinctly alternate, with a marked reddish colour: after this the plant is easily recognized.

Pricking out.

7. When the seedlings are one to two inches high in the seed beds or boxes, they should be transplanted into nursery beds, and put out in lines about a foot from each other. The nursery beds should be well-raised and drained, but the soil need not be so carefully prepared as for the seed beds. Here the plants are kept till the following rains, when they are dug up and taken to stockaded nurseries in the forest, and put out 5 × 5' on raised well-drained beds, where they remain for two years till they are required for planting operations.

Forest nurseries.

8. Almost every animal will eat the young rubber plants; it is, therefore, impossible to plant out small seedlings in the forest, owing to the destruction by the wild elephants and game, unless each individual plant is carefully fenced in. As this is too costly, and the rubber after it is 1—2 feet in height is very hardy and can be transplanted, with ordinary care, at any time of the year (the best time in Assam is between May and July), the seedlings are kept in stockaded nurseries in the forest where planting operations are to take place, and remain there till they are 10 or 12 feet high, that is, about three years after germination, when they are dug out and the roots are cut back 18 inches right around the plant and planted on the mounds in the forests.

Planting operations.

9. In artificial planting it is found that the rubber grows best on mounds, Lines are cut through the forest 20 feet wide and 70 feet apart from centre to centre; in these lines 15 feet stakes are put up 35 feet apart, Round each stake a mound is thrown up four feet high, The base of the mound is about ten feet in diameter and they taper to four feet on the top; on this mound the rubber tree is planted, care being taken that the roots are carefully spread out before they are covered up with earth. To prevent animals pulling the plants and wind blowing them down, they are tied to the stakes.

Cuttings.

10. The rubber tree can readily be propagated from the cuttings, if only perfectly ripe young branches or shoots are used, but the tree raised from cuttings does not appear to throw out aerial roots,

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and, as the future yield of the tree probably depends on its aerial root system, it is questionable whether trees raised from cuttings *ought to* be used except where required only as shade givers, such as in an avenue. In the Charduar rubber plantation, propagation by cuttings was given up very early, that is about 1876, the plantation having been commenced in 1873.

The best time *to take cuttings is May and June.*

General.

11. The rubber grows equally well on high land or low land, in forest land or grass land, so long as it is planted on a mound and *its roots are* not exposed to the sun. It is a surface feeder, but, as soon as its roots appear above ground, they must be covered with fresh earth *until such time* as the tree has formed a sufficient leaf canopy to protect itself.—(*Assam Forest Report 1896-97*).

Working Plan Report for the Moharbhanj State.

PREPARED BY C. C. HATT, I. F. S.

Moharbhanj is a small State covering some 5,000 square miles of more or less hilly country, situate near the coast of Orissa, between Bengal and the Central Provinces, that is to say between Midnapore, Singhbhoom, Balasore and Cuttack. The interior hills rise to near 4,000 feet and graduate off to undulating lands towards the boundaries. The climate is most unhealthy and the petty officials were unwilling to render any assistance to the working plans party. A proper working plan could not be made, but some important steps have been taken towards it. Nearly 2,000 square miles have been indicated as forest, some to be protected, and some to be reserved, but only two areas of 51 and 36 square miles, respectively, have been proposed as regular Working Circles. The principal species is sal, for which there is a good demand, but other species, such as *Diospyros Melanoxylon*, *Pterocarpus Marsupium*, *Dalbergia latifolia*, *Gmelina arborea*, and *Ougeinia dalbergioides* are appreciated. The soil consists of metamorphic rocks of all kinds, gneiss, granite, quartz, laterite both as plateaux and in the plains, and alluvium of various characters, with and without lime nodules. The laterite soil is poor, the alluvium, generally a stiff yellowish whitish clay, is suitable for cultivation. The rainfall varies between 50 and 70 inches annually, the maximum being in July and August, when 10 to 20 inches may fall in the month.

The way in which forest is turned into cultivation is as follows:—The undergrowth and small trees having been burnt and cut away, the larger trees are ringed and left to die. The land thus roughly cleared is called "Dahi" and after ploughing is sown with early paddy, oilseeds, etc. After two or three years crops, the soil, if lateritic, is usually abandoned, but if alluvial, the stumps are removed and the land thoroughly cleared, it is then called "Asu" and is more valuable. If water is available for irrigation, bunds and cuts are made, and the land becomes valuable "Jal." The wilder people never get beyond the "Lahi" stage, which is practically the same as "jhum" in Assam, and the state of the forests bears eloquent testimony to its ruinous effects, thousands of rupees worth being burnt for a few pice worth of grain.

All the forests belong entirely to the Raja, who is endeavouring to follow an enlightened policy and do for his people as much as they will let him, but his task is made difficult by the prejudices and ignorance of even the officials of his state. The Forest Act is to come into force, and the forests will be notified under it as Reserved or Protected. The latter will be worked especially for the benefit of the people, who pay a cess to the State for their firewood, as for wood for houses and implements, taking what they want from the forest in return. Mr.

Hatt probably speaks loosely in calling this a "*right.*" The division into Reserved and Protected is unnecessary and impolitic; as it has long been recognised that the latter class is a failure and cannot be protected at all, while it is quite easy to arrange for popular privileges in Reserved Forests, even to the extent of ruining the latter. The notification of any lands whatever as Protected Forest unless, perhaps, purely village grazing areas, cannot be too strongly deprecated.

The Moharbhanj forests, in their present state, appear to resemble in their sufferings, the Reserved Forests of Bombay, about which a good deal has been said from time to time. Within reach of villages, the forest is grazed "to the point of extermina-'tion." The villagers "cut, hack about, and remove the large 'trees and poles that are still remaining, and thus form a third 'auxiliary to the fire and cattle, in their anxiety to produce a 'howling wilderness at the shortest possible notice." But the great enemy is fire, "the whole countryside for miles round is ablaze, 'this commences about the middle of February and continues 'incessantly till put a stop to by the rains about the end of May. 'The object in view is to clear away the undergrowth and thus 'facilitate shikar and locomotion generally through the forests." This reads exactly like the growl of a Bombay Forest officer concerning his Reserves, only in Moharbhanj there is not yet the pretence of protection. Another general method is to apply fire to the bases of the large trees, so as to increase the size of the clearing and drive the forest boundary further and further.

The forests seem to have been originally preserved for shikar. The earliest attempt at working them regularly was by selling a timber-route to the highest bidder, who was entitled to take out everything he could get along his route. "This let in 'the big contractor, the thoroughness of whose work is testified by 'the present condition of the plains forests . . . There is a wealthy 'Babu in Balasore the bulk of whose fortune was made in this 'manner. . . having made a clean sweep of all the trees over 3 feet 'girth. The extent of forests denuded by this man amounts to 'about 200 or 300 square miles." That is a fleabite compared with what has sometimes gone on in British territory, when the Forest Officer knew that his only chance in life lay in pleasing the Revenue Department to which he was subordinate. This vicious spur is still in action, and will act as long as the Forest Department is not independent of such stimuli.

The late Maharaja stopped the route system, and issued orders prohibiting the felling of certain trees without permission, but the benefit has been nullified by "the utter disregard shown by 'the subordinate revenue officials" and "the forest is mutilated in all 'directions, and thefts of timber are carried on without any attempt 'at concealment all over the state." Just like our Bombay colleagues again, but Moharbhanj is not blessed with a power of

compounding offences, ridiculous in its extent, and now considered far more dangerous to the officer than to the thief. The route system was followed by a lease system, the conditions being characterised by all the "childlike and bland" innocence of the drafting Babu whose father-in-law is the contractor. The lease runs for 9 years, during which time, having due regard to the checks upon him, the lessee has in practice the faculty of taking out everything he chooses to lay hands on. There is no penal clause for breach of conditions, and examination may only be made at two places outside the state territories, and therefore jurisdiction. This last is an exceedingly artistic touch. It is, in fact, doubtful whether the absolute monarch's favourite expletive, "Off with his head," is quite the useless anachronism we pretend it is. Another lease covers all the "dry timber" within an area of 500 square miles. It likewise covers all the green, as is the occasional custom in British territory also. But the Raja has wisely cancelled this lease, though he may hereby incur the reputation of a spoilsport among the more astute and unscrupulous of his subjects. The Forest revenue has risen from Rs. 13,773 in 1884-85 to about Rs. 38,000 at present, two-thirds of it being derived from the household cess on wood. When 60,000 cubic feet of good sal timber are let go for Rs. 2,301, it is apparent that there is some hope of the revenues expanding freely under judicious treatment. A log of 30 cubic feet is worth Rs. 45 in Midnapur, and the carriage costs Rs. 9-6-0, so that a purchaser could afford to pay 4 as. per cubic foot to the State, and still make 30 per cent profit.

The Reserved forests include about 1,000 square miles. In this area no sound and promising sal whatever is to be cut. The treatment is to consist in the removal of bad and unpromising sal, with other kinds of trees as required, and all minor produce. The object is to re-establish sal where its supremacy has been imperilled. The crowns of seedbearers are to be kept dense enough to touch when swayed by the wind, until such time as a young crop is obtained. The different species are placed in the following order of merit, which, would perhaps, not be the same in all districts, (1) *Shorea robusta*, (2) *Diospyros Melanoxylon* (3) *Pterocarpus Marsupium*, (4) *Dalbergia latifolia and Sissu* (5) *Chloroxylon Swietenia* (6) *Soymida febrifuga* (7) *Ougeinia dalbergioides* (8) *Gmelima arborea* (9) *Adina cordifolia* (10) *Terminalia tomentosa* (11) *Albizzia Lebbek.*

The two small working circles are selected simply because they contain the most accessible of the remaining mature sal. The difficulty will be to get rid of the useless material to make room for good trees. The method adopted is selection, with the object of utilizing mature trees while at the same time improving the general condition and constitution the forest. The felling

cycle is ten years, and of the blocks or compartments are laid out simply by ocular estimate.

The exploitable size is fixed at 7 feet girth, as between 7 feet and 8 feet some 27 per cent, of the trees are unsound. But this unsoundness is artificial, and will disappear with good conservancy, so that the exploitable size may ultimately be raised to 8 feet. The possibility is estimated at 1,000 to 1,500 trees annually each circle. This is a considerable margin, which will be brought within closer limits presumably by the state of the canopy, on the due maintenance of which Mr. Hatt very properly lays great stress. By the end of the 10 years much road making will have been got through, the plan will, if necessary, be revised, and perhaps by that time it may be possible to bring other areas under working plans. This will however depend mostly on the progress made with the roads.

The protected area includes about 1,100 square miles of inferior forest, and 760 square miles of jungled waste. In the impossibility of providing forest guards the safety of this area will be entrusted to the actual village officers who are at present aiding and encouraging every kind of loot, just as obtains in certain much more important British districts. These men are to be kept virtuous by exempting them from the wood-cess, but it is doubtful if they can be persuaded that Rs. 5 remission is superior to Rs. 25 loot, plus popularity. The production of tusser silk is stated to invariably result in the "complete destruction of the forest" in the areas utilized. The Report is accompanied by 5 excellent maps.

F. G.

V—SHIKAR AND TRAVEL.

A Shikar Story.

DEAR MR. EDITOR

I send you the enclosed history in great trepidation for, in the first place, you will probably be inundated with Shikar stories, the result of Tawkwé's appeal to you, and your appeal to Tawkwé; and secondly, I dread Tawkwé's criticism, for we have no sample of his work on which we can regulate our own composition. But it is a simple story and there are no spots and few stripes.

O. C.

"Fortune is merry
And this mood will give us anything."

T'is not for me to explain events, but merely to record them. The facts are simply that four ponderous and ancient tigers had for years roamed in the Sal Forests of one of the submontane districts of the N.-W. P., and defying all the wiles and tricks of a

host of sportsmen, and that they all died within three weeks, succumbing to the simplest of artifices. So great was the familiarity of the country-side, that each tiger had a name—there was the Bankati tiger, the Chandparah tiger, the Domohani tiger, and the Phuta Kua tiger. Whenever other sport was scarce, we used to play with one of these monsters: he reciprocated the joke, and, as a reward, received a full meal of beef, but he never went so far as to offer his striped carcase as a target. The Bankati tiger began it, he frightened a tied-up b uffalo till it broke its rope and fled to its companion; the tiger followed in the track and killed the companion, dragging him away for a quarter of a mile into thick green grass some 10 ft. high. We constructed a machan on a sal pole. It was conspicuous; our only hope was, that the tiger would come through the grass, and so not observe the naive attempt at concealment. At 5 *p. m.* a "Kakar" informed us, with satisfying reiteration, that his majesty was on foot, and a few minutes later we heard him crashing through the grass. The buffalo lay in a little circuit of beaten down grass some 6 ft. wide, and the tiger protruded his head into this well of vegetation and seemed astonished at the light thrown on the subject. He advanced one step and the next instant, as the shot rang out, he was charging wildly through the high grass. After a run of some 50 yards, he changed his mind, revenge seemed to possess him; returning at the same speed, he ended his life with a magnificent spring which landed him some 15 yards from the buffalo. We brought him thence and then the secretive villagers confessed to a tale of woe. Each had lost the pet lamb of their flock: to believe them, the Bankati tiger had decimated the herd.

The Chandparah tiger continued it. He took to walking one road every night, and one evening he found a buffalo on his path; he was very startled at this operation and bounded heavily away, but returned and killed and ate. He selected a small island of thick young growth surrounded by a sea of grass in which to hide his meal. The place seemed impossible, but we tied up a machan on the mainland, and blockaded the island from one side only. Any other tiger must have come from the other side, but the Chandparah tiger arrived at sunset from the rear; he puffed and panted as no blockade runner should, and to crown his folly, stood to take breath before crossing the open. When he did cross, he had two bullets through him, and the passage was accomplished under fire. He reached the other side and lay stretched, a silver tiger, in the beams of the rising moon.

The Domahani tiger I can only write of with regret and remorse. He was the friend and playmate of my youth. Living close to the house in inaccessible ravines and heavy grass, he was always ready during the past 20 years to accept hospitality but never to return it. He was invariably out when one dropped in, and the countless offerings he had absorbed, had been duly appreciated; he did credit to his gram. His fore pads were eight

fingers across, without the toes, and his figure was far from elegant. What possessed the old fellow to kill a buffalo and drag it away from his favorite ravines cannot be explained. He ate half of it and left it lying in the sal forest, we thought he had as usual abandoned it. It was getting dusk and timber carts had passed with bewildering creaking, with shouts and songs of nervous drivers, when a shadowy form stood near the kill. Now or never the fading light insisted, and we strained our ears to get some evidence of the result of the shot. A slow trotting for a short distance through the forest, then silence, intimating that the tiger had subsided into a walk. We went home grieved but not astonished at the escape of our old companion. The next morning we found the tracks of a great tiger crossing the road towards the kill. It seemed conclusive evidence that our friend had recovered from his fright and had resumed his meal. The buffalo had been moved, fresh drops of blood from the carcase showed that we had disturbed a chota hazri. Shamefac ed before the trackers we brusquely gave the order to remove the machan, yet took one more sorrowful look at the deep claw marks made the night before by the startled tiger. We sat down and took the angle of fire; and puzzled, gave the order to track up as far as possible. At 20 yards one drop of blood; at 30, the tiger had lain down, and so, carefully picking up the evidences, at 200 yards we we found him dead and stiff in his favorite "Nalas."

The Phuta Kua tiger had thus fortuitously arrived during the night and had partaken of the Domohani tiger's meal. The next day he killed a herd buffalo and dragged it across the river, taking up the quarters vacated by the Domohani tiger. On the third day he accepted a bait but left it lying near water and grass. The machan was favorable, we looked down into a sea of grass, at our backs the well known ravines. The grazing buffaloes drew off at sunset in response to the weird calls of the herdsmen, and while they were yet in sight, the tiger came out of the forest and flung himself at full length in the green boggy soil. For full 10 minutes he lay rolling over and over but screened from view by an intercepting bush. It was getting dark and we risked standing up in the machan, aiming at the parting of the white hair between the forelegs. The bullet was arrested in the strong bones of shoulder and spine, and the tiger fell dead 20 yards away. The jungles are now lonely and silent, no belling sambhar or noisy kakar disturbs the night, and we must wait till other tigers find out the convenience of these happy hunting grounds, before we can again regard them with feelings of interest, or expect to find Fortune in a merry mood. I will not trouble your readers with details of measurements. Suffice it to say that the quartette measured exactly 40 feet and that the largest skull was not $\frac{3}{4}$ inch less in combined length and breadth than that spoken of in Blanford as immense.

O. C.

VI.—EXTRACTS, NOTES AND QUERIES

Timber and other Trades of Cuba.

Throughout the civilised world the struggle which now centres around the shores of the island of Cuba is of absorbing interest and although we, as a nation have no direct concern in the questions at issue, still it is of no little importance to us from a commercial standpoint. Owing to the unsetled state of the country, our trade with Cuba has been shrinking for many years, and during the progress of the last rebellion it has dwindled down to very small proportions.

In 1888 the value of our exports to the Spanish West Indies amounted to £2,734,500, whereas in 1895 they were valued at £443,640 only; and our imports from the unhappy countries which in 1888 were valued at £323,028, had fallen away in 1893 to £131,567. Our exports were of a very miscellaneous character, but cottons and piece goods predominated largely. Ten years ago we sent 55 million yards of cottons, but two years ago we only sent 26 million yards.

Our principal imports from the Spanish colonies are rum, tobacco, coffee, and wood. Mahogany, cedar, lignum-vitæ, ebony, *genadillo, live oak, fustic, quebracho* and rosewood grow to great perfection in this topical climate. The mahogany is highly esteemed in the European markets, being second only to best Spanish wood from St. Domingo. The quantities of these valuable woods reaching our shores has been diminishing yearly during the period of disturbance in the island; the late insurrection however has never altogether stopped the export.

The import of mahogany and hard woods of *all kinds* to England has been as follows in the respective years:—

	Tons.		Tons.
1888	... 8,397	1892	... 4,021
1889	... 6,347	1893	... 4,891
1890	... 5,323	1894	... 8,662
1891	.. 5,554	1895	... 3,805

It will be noticed that in 1894 there was an increase, which consisted of a large quantity of small and inferior mahogany and cedar shipped that year from Nuevitas. The 3,805 tons exported to England in 1895 was valued at £22,363. The shippers of Cuba mahogany and cedar, we conclude, take a very lively interest in the European markets, judging from the number of subscribers to the "*Journal*" in the island.

When a stable Government is established in the island there is little doubt but that our commercial relations with the Cubans will rapidly increase to their former proportions.

Cuba is the largest island of the Antilles, and the most important colonial possession of Spain. It has a length of rather more than 750 miles, and an average width of 50 miles, its area being about 40,000 square miles. It is larger than Ireland and less in area than England. It was discovered by Columbus on his first voyage in 1511, and from the salubrious climate it enjoys and the productiveness of the soil it is called the "Queen of the Antilles." The population of the island is little over a million and a half, consisting of about a million whites, nearly half a million coloured, and some forty thousand Asiatics.

Cuba is evidently of volcanic origin, which has given her a bold coast in many places, with numerous and fine harbours Along the north shore are Bahiahonda, Cabanas, Mariel, Havana Matanzas, Cardenas, Saguala Grande, Caibarien, Nuevitas, Manati, Puerto Padre Gibara, Banes, Nipe, Levisa, Tanamo, and Baracoa. Along the south shore are Guantanamo or Cumberland Harbour, Santiago de Cuba, Manzanillo, Casilda, Jagua or Cienfuegos. Some of these are magnificent in size and depth of water, and their names are familiar to the European mahogany trade.

Lying along the north shore are 570 isles and keys, while the southern coast has 730, a total of 1,300.

The geographical situation of Cuba is extremely favourable to commerce, while its extraordinary fertility of soil and magnificent climate make it a treasury of natural resources. Topographically, the island presents every phase of surface and altitude. A chain of mountains extends from east to west, forming, as it were, a backbone to the land. This attains in places an altitude of 8,000 feet, giving a wide range of climate and atmospheric conditions, together with a varied flora. Another range, about 200 miles long, skirts a part of the Southern Coast. The rivers, of which there are about 250, flow from the mountain heights to the sea. They are rapid and picturesque, and water valleys whose fertility and beauty are unsurpassed perhaps anywhere on earth.

Havana, the metropolis of the island, has a population of 200,000, and is an important commercial centre. Its admirable situation makes it the emporium for Central America, being situated on the busiest thoroughfare of the Western hemisphere.

The whole of the trees growing on the island are hardwoods and unsuitable for constructive purposes; all building timber, therefore, has to be imported, and the nearest producing country being the United States, both the export and import trade with Cuba is of considerable importance, especially to the pitch pine districts of the South.

In time of peace they always have been important buyers of pitch pine, and now, with ruined towns and desolate plantations to rebuild when peace shall come again, they will require a quantity

of material which will tax the gulf mills to supply. When the task of rehabilitation comes, and immigration and material development sets in, it has been estimated that the demands for lumber alone, in such a case, will aggregate not less than 300,000,000 feet or 5,000,000 loads annually, or 200 feet super per capita, and this would afford a good outlet for the lower grades of pitch pine lumber.—(*Timber Trades Journal.*)

Vulcanizing Wood by the Haskin Process.

On the 27th January last, a demonstration of the Haskin Wood Vulcanizing Co.'s extensive machinery and plant, used in the process of *Haskinizing* (or *vulcanizing*) wood, was given at Millwall, London, on the site of Samuda's Old Shipbuilding Yard.

The question of wood preservation is one that has necessarily engaged the minds of eminent scientists and inventors for many years, but the success that has attended their efforts up to the present has been but small.

The original idea, which has been worked upon up till now, was to take the sap out, so as to permit the injection of other substances into the wood, whereas it has been proved that the sap should be retained, and made to preserve the wood, being composed of certain albuminous, nitrous, oily, and resinous substances. Thus does the act of nature, by her laws of heat and atmospheric pressure, create in course of time the hard, sound fibre of the wood.

When wood is heated, as in ordinary distillation, the substances composing the sap that have not been converted into the fibre, are not extracted, but chemically changed, and form a most powerful antiseptic mixture. This has been separated for commercial purposes into acetic acid, methyl alcohol, methyl acetate, and tarry matter containing phenol, creosote, carbolic acid, etc. These chemicals result from the action of heat upon the natural sap of the wood, and are entirely different from the sap of the tree in its natural state.

Up to the present "Charring" has been the operation chiefly relied upon to resist the effect of decay from exposure to moisture. Stakes and piles are generally thus treated before being driven into the ground. Casks are charred by coopers when they are intended to hold water; and the experience of ages has shown, beyond all question, that the charring of wood will preserve it from decay, so far as the heat penetrates beyond the flame line. By this process wood has been made to last for centuries. Specimens were taken from the pyramids of Egypt, and several logs of wood were found which had been divided

in the middle, chamfered off at each end, the inside dug out and burnt or charred, both on the inside and on the outside. The burnt surface appeared to have been extinguished by immersing the dug-out in water. Afterwards they were covered with some kind of papyrus, or cloth, highly ornamented and used for burial cases more than 2,000 years ago, and are now in a good state of preservation. Charring is based upon the only correct principle, that of "utilizing the natural fluids in the wood" by the application of heat.

But in charring the heat cannot penetrate to the centre of timber without burning too deeply; some of the fluids are not reached, while others escape and are lost in the operation; hence charred posts and timbers are found sound to the depth of half to one inch (so far as the heat had penetrated) but rotten in the centre.

Now Haskinizing (or Vulcanizing) deals with the natural fluids or properties contained in the wood itself—and consists in placing raw wood in a cylindrical treating chamber, made of boiler-plate of any size, or numbers of them placed together—according to the output required—and submitting the same for a few hours to a medium of superheated, circulating, compressed air, which effects the chemical change. The air pressure employed prevents evaporation, while the intense heat passes through to the centre of the timber, causing the constituents to organize into an oleaginous compound, saturating the fibre, and filling the pores. In cooling down under the same pressure, the new compound becomes consolidated with the fibre, thus indurating, strengthening, perfecting, beautifying, and preserving the wood from decay.

The germinative principle inherent in the sap is destroyed, all fungi, germs, or insect life are killed, and no offensive odour is emitted from the wood after treatment.

Heat increases the affinity of substances for each other. It is a remarkable fact that water, under pressure sufficient to prevent its escape into steam, may be so highly heated, that it will decompose natural fat, and, as an organic base, form a perfect and fixed combination with certain fatty elements.

Haskinized wood makes excellent railway sleepers and timbers of all kinds for stations; telegraph, telephone, and signal poles; bridges, docks, piles and mining timbers; for shipbuilding, masts, decks, interior woodwork, etc. It is tough and strong.

The great value of the process is due to its fixing the 55 per cent. of fluid matter within the wood in a condition such that it cannot ferment or vegetate; nor is it liable to dissolve or wash out, but is evenly distributed, filling the wood cells and ducts, and debarring entrance to moisture or germs of decay.

There is no doubt but that the preservation of wood from decay alone will benefit the world equally as much, if not more, than the combined products of all the great inventions in the treatment of iron and vegetable substances.

Shortly, the process is the subjection of timber to air at high temperature and pressure. The temperature used may be as high as 400° F., and the pressure as much as 200lbs per square inch. The effect of this is to sterilize the wood, and impregnate it with antiseptics, and this impregnation has been effected in the cells and fibre of the wood itself, by parts of the wood having been raised to the critical temperature at which resolution of the less stable fractions and of the woody tissue begins.

There is no doubt that the Haskin process is one that depends for its success on precision in working.

The plant exhibited at the inspection consisted of two cylindrical vessels, each 120ft. long by 6ft. 6in. diameter, secured at the further end, but free to move over rollers, when their temperature rises during the process. These vessels are built of boiler plate, and are made in sections, so as to facilitate jointing and transport. The end nearest the wharf is closed by a door of very ingenious construction, the same being counterpoised and controlled by a hand wheel, by which it can be shut to, and opened, for the insertion of a load of timber in less than two minutes. The wedge-shaped bars, actuated from the centre of the doors by a peculiar gear, are shot into their slots by a single operation. These doors weigh, we understand, something between eight and ten tons, and being worked on a hinged arm, are both novel and ingenious.

In the cylindrical receptacles the wood is subjected for about eight hours to the action of air at a temperature of 400° F., and at a pressure of 200lbs. on the square inch.

Tram rails run the whole length of the cylinders and are connected with the rails that run from the edge of the wharf; also steam pipes used for the initial warming of the cylinders before the actual treatment of the wood begins. When the timber to be treated has been run in on trucks, steam is turned into these pipes, and the exuding moisture from the exterior of the timber is expelled, and run off through cocks at the bottom of the cylinder. The latter are then shut, and heated compressed air is driven in. Air-compressing engines supply this, having steam and air cylinders both 18-in diameter by 30-in stroke. The air is compressed at one stage to a pressure of 200lbs. per square inch, and to aid this, water is injected into the air-compressing cylinder, so as to cool the air heated by compression. A water separator next dries the moist compressed air by its passage. The air is now pumped by a circulating pump through tubes heated by live steam, and thence through a sort of pipe stove, heated by coke. Its temperature is raised to 400° F., and it is ready for delivery to the timber-treating cylinders, where its constant circulation is fully maintained. From these it passes to a tubular cooler, and is taken to the circulating pump, and sent again through the same evolution. Any loss of pressure in the course of circulation is easily made good by use of the compressor. Of course, the

temperature employed depends on the class of timber to be treated, and may in some cases be such that the heating of the air can be performed by live steam without the curriculum above set out. *Where, however, sleepers are concerned, a high temperature* is essential, as they are subject to so many destructive agencies.

The works as inspected are admirably fitted for their purpose, and ample provision has been made for necessary extensions should the process become commercially adaptable, and be taken up by the proper parties.

Steam, for all the purposes mentioned, is provided by three Galloway boilers, 28ft. by 7ft., working at a pressure of 200lbs. per square inch. The whole plant, indeed, has been constructed by Messrs. *Galloway, and is of the most improved and substantial* description. We will describe the boilers at length later on.

Five different experiments have been made with Haskinized wood for the purposes of ascertaining whether the white ant would pursue its ravages with this wood as in the case of ordinary timber, and the results were somewhat startling. A strip of Haskinized wood was placed in a nest of ants in Burmah, and left for three months ; when the nest was visited after the expiry of that period, it was found deserted, and the wood untouched. A like experiment was conducted on two subsequent occasions, with the same result. The value, therefore, of *this Haskin process for* Indian requirements can scarcely be over-estimated ; for not only has it thus proved itself impervious to the white ant, but it apparently effectually disperses them, and, therefore, vulcanized wood, under this process, should have a fair future in front of it throughout India.

The exact chemical effect produced by the process has not yet been definitively settled, but certainly it should be of sufficient theoretical interest, and practical importance, to justify close and systematic investigation ; and no doubt this will be undertaken now that the process has become a commercial fact.

Many of the American Railway Companies are already using sleepers preserved by the Haskin process; and several railway companies in England have notified their intention of giving sleepers, treated by this process, a trial. With regard to the Galloway boilers employed by the Company, we may mention that they are each 28ft. long by 7ft. diameter, and are capable of evaporating 6,000lbs. of water per hour with average coal and draught. They are suitable for a 200lbs. working pressure, the shell plates being thirteen-sixteenths of an inch thick, and other parts in proportion. They are constructed of the best mild steel, capable of withstanding a tensile strain of 26 to 30 tons per square inch, with not less than 20 per cent. elongation in 10 inches.

The furnaces are 2ft. 9in. in diameter, and the flue plates are supported by 30 Galloway cone tubes, and 10 patent pockets are fixed in the flue to divert the flame amongst the cone tubes.

The boiler ends are solid, rolled in one piece ¾ in. thick; and, before leaving the works, each boiler was tested with water pressure of 300lbs. per square inch.

The usual mountings are fitted on the boilers, and a **2** in. *feed valve is used. The dead-weight safety valve is of 5in.* area, and there is one high steam and low water safety valve on Galloway's patent. A 6in. steam junction valve (ranch pattern) is used, and the usual anti-priming pipe, gauges, etc., are attached.

As before mentioned, the machinery has been supplied by Messrs. Galloway, of Manchester, and certainly the material, workmanship, and efficiency of the whole plant, redound to the already high reputation of this firm —(*Indian and Eastern Engineer*).

Forestry Education. *

By Dr. William Schlich, C. I. E.,

Professor of Forestry in the Engineering College for India, Coopers Hill.

About eight years ago this Society paid me the compliment of electing me an honorary member. While most cordially appreciating the honour, I have for some time past felt very uncomfortable, because I have, up to date, not been able to show in a tangible way to what extent I consider myself under an obligation to you. Hence, when our worthy President invited me to to address you to-day, I seized the opportunity most eagerly, trusting that the remarks which I shall be able to offer to-day, may in some small degree contribute to the furtherance of the aims and objects of the Society; and I further trust that the present occasion may be only the beginning of my becoming more closely connected with the work of the Society, than has been the case in the past.

Our President left it entirely to me to choose a subject upon which to address you. I considered the matter, and I arrived at the conclusion that I could not do better than to offer a few remarks upon the question which, I know, has of late been uppermost in your minds, namely, "Forestry Education." This subject is all the more congenial to me, as I have for many years past been associated with the education of foresters, and if I know anything at all, I ought to know something about the requirements of forestry education.

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* An address delivered at the forty-fourth Annual Meeting of the Royal Scottish Arboricultural Society, held on the 27th January, 1897.

Is Better Forestry Education Wanted?

The first point which demands our attention is—Whether a case for better forestry education than has hitherto been obtained in this country, has been made out?

Gentlemen, forestry is an "industry," and, like all other industries, it is subject to the law of demand and supply. Until a recent time the demand was for arboriculturists and not sylviculturists. That demand was admirably met by the corps of gentlemen who attend to the aboriculture on the various estates of this country. To expect that these gentlemen should suddenly turn into experienced sylviculturists, to suit a demand which has only lately sprung up, is hardly fair. Until recent times the economic question was, as far as the bulk of British woodlands is concerned, of minor importance, since these woodlands were maintained chiefly for other objects, such as beauty of landscape, or the production of fine specimens of trees grouped in picturesque fashion over the estates, or for game coverts. I am sure I may safely say that these requirements were admirably met by Scottish wood managers. But of late, however, a change has come. Agriculture has fallen low, and the rent-roll of many proprietors has been seriously affected. The economic or financial importance of woodlands, and the profitable utilisation of waste lands, have come more into the foreground. Hence the increased demand for skilled sylviculturists as wood managers, who are fully acquainted with the economic aspect of the industry. This is all very well. But forests which have been hitherto managed for other objects cannot suddenly be converted into what I call "economic forests." The change takes time, and if proprietors are beginning to get impatient, they have clearly only themselves to blame. The transition from the one condition to the other takes a considerable space of time, and it demands the greatest skill of the sylviculturist to effect it without loss to the proprietor; in fact, it means, in only too many cases, the gradual utilisation of the woods now existing to the best advantage, and the production of new woods which will meet the requirements of modern economic forestry, and not of arboriculture. The thing can be done, but the operation requires the training of wood managers on lines somewhat different from those hitherto followed in this country.

To understand the difference between the two things more fully, it will be well if I touch for a few minutes on the principal causes why the timber now produced in Britain cannot compete with that imported from abroad. On this subject so much has been written and said of late that I can compress what I have to say into a few sentences. Indeed, the *Transactions* of this Society during the last two years are a very storehouse of information on the subject.

You are aware that the general drawback, from which forestry in this country labours, is the absence of a regular demand for

home-grown timber. You also know that, until a comparatively recent date, at any rate, most Government contracts for works of construction contained a clause to the effect that no home-grown timber would be allowed to be used. If we take those broad facts into consideration, it is easy to perceive that the explanation may be condensed into the following two statements :—(1) The home-grown timber is, generally speaking, inferior in quality to that imported from abroad ; (2) it comes into the market at irregular intervals and in fluctuating quantities. Exceptions exist, but here only the average conditions can be considered. These drawbacks can be removed only by improved sylvicultural methods, and a systematic management of the forests. You all know now that the plantations in this country have been too heavily thinned during the first half of their life. By such a procedure you can, perhaps, secure an increased average production per year and acre, but at the cost of quality. Here I mean the quality of timber now produced does not fetch the same price as that imported from abroad. However much we may demonstrate that the timber grown in this country is of as good or even better lasting quality, still the eating of the pudding is the proof thereof. The fact remains as stated above.

I need hardly remind you that, in the case of most estates in this country, cuttings are made at irregular intervals. Sometimes a proprietor prefers his woods to the cash which he can realise from them ; in others, exceptionally large quantities are cut all at once to meet a special demand for money ; and last, but not least, frequently enormous quantities of timber are thrown down by an exceptionally strong gale.

All these things are detrimental to a profitable utilisation of the material. Under such conditions a regular market cannot be developed, nor rational and cheap methods of converting the material be employed. The whole thing is haphazard, and neither the proprietors nor the timber merchants derive the full benefit which the industry is capable of yielding. This state of *things can be remedied only by a systematic working of the* forests, so that annually the same, or approximately the same, quantity of timber is offered for sale. Timber merchants, knowing this, will make their arrangements accordingly. A regular demand for the produce, and a well-organised trade in home-grown timber, will be developed. Improved means of extracting the timber, better means of communication, and high-class saw-mills will make their appearance, leading to a considerable reduction in the cost of extraction and conversion. In the same degree, an increased surplus is realised, the greater part of which will, following the law of gravitation, find its way into the pockets of the proprietors of the forests.

In order to bring this about, the first and foremost requirement of our forest estates is, then that they should be managed according to well-considered plans of operations, technically called working

plans, which lay down the cuttings to be made for a series of years, thus leading to the method of a sustained yield. But working plans do more than this, they provide for the systematic and orderly performance of all other work to be attended to, such as the general method of treatment, the execution of regeneration, thinnings, construction of roads, etc., in short, for the whole business connected with forest management.

And this brings me to the next point, namely, the interference caused to an orderly systematic management by violent gales. No doubt this is a great source of annoyance in a country situated like Scotland. Although the forester cannot altogether prevent such disasters, he can do much to reduce their extent, partly by grouping the woods of different ages in a reasonable manner, and partly by mixing shallow-rooted species with deep-rooted ones.

Most strong gales come from a fairly fixed direction; in this country generally from a direction oscillating between north-west and south-west, in so far as deviations are not caused by the configuration of the locality, such as mountain ranges, deep valleys, etc. It is also well known that gales do special damage if they rush into the open front of the wood, or one which has suddenly been too heavily thinned. If, therefore, a cutting has been made by which the western front of an adjoining wood standing on the lee side is exposed, it is as likely as not that the next heavy gale will throw it down. If on the other hand, we arrange the cuttings so that they begin in the east, and proceed gradually towards the west, we avoid offering to the wind specially favourable conditions for causing havoc. The wood at the western edge having grown up gradually under constant exposure to the western gales, will have developed strong edge trees, especially if they have been somewhat heavily thinned during early youth, and they will, in the majority of cases, resist gales. Hence they should not fall under the axe until all the woods behind them have been cut over.

Mixed Woods.—Again, it is highly desirable that shallow-rooted species, like spruce, should be mixed with species which have a firmer hold on the soil. In this respect, I remember a remarkable instance. When I was a forest student I joined an excursion to the Thüringian forest under the guidance of my old teacher, Dr. Gustav Heyer. There we were one day shown an old wood of spruce and silver fir, about 140 years old. On examining the wood we found all the trees in rows running from west to east, and every edge tree on the west was a silver fir. It is well known that nobody thought of planting or sowing in rows 180 years ago in those out-of-the-way places, so that the wood was evidently the result of natural regeneration. Hence the only possible explanation was that the silver firs along the western edge stood as well as the trees behind them; where the edge trees were spruces, they had, in the course of time, been

blown down, carrying the trees behind with them. Thus the whole wood appeared as if it had been planted or sown in lines. As already stated, the forester cannot prevent all accidents of this class, because sometimes woods are blown down, even if all possible precautions have been taken, especially as gales are occasionally perverse, and blow from the east; but anyone who cares to visit, for instance, the kingdom of Saxony, will be astonished to see what the skill of the forester can do in this respect. The Saxon State forests have, for many years past, been managed on the financial principle, and they yield a revenue far higher than those in any other State known to me. Now, the best paying tree in Saxony is the common spruce, as it yields heavy crops, of which up to 80 per cent. are classed as timber, and which is used for a variety of purposes in construction, and also for the manufacture of paper pulp, an article becoming more and more important to the forester and forest proprietor.

Spruce, as you know, is very liable to be thrown by wind, in fact, more so than almost any other of our forest trees, and yet in Saxony spruce woods flourish. Indeed, the damage done by gales is wonderfully small. This is achieved by managing each forest charge according to a well-considered working plan, which lays down the general grouping of the different age classes, so that no cutting causes an open front to be exposed in the direction from which the strong winds generally blow.

I cannot follow up this subject on the present occasion, but I desire to add that, in my opinion, there are, for British wood managers, no more interesting forests and forest management to be seen than in the hilly parts of Saxony; and if any of you should again go to Germany, do not return without having paid a visit to the forests in the vicinity of Schwarzenberg in the kingdom of Saxony.

Natural versus Artificial Regeneration.

And now there is one more point on which I should like to offer a few remarks before I proceed to forestry education proper, and that is the question of natural *versus* artificial regeneration. You have been told on various occasions, and by various authorities, that you must study natural regeneration, so that you may regenerate your woods without expense and without exposing your soil to the effects of sun and air currents. Indeed, some people have gone so far as to declare that the salvation of the forest industry in this country depends on the introduction of the system of natural regeneration. The question which I should like to ask is, "Have the advocates of this theory not gone a little too far?" In answering the question, I shall begin by telling you that the cleared areas in the splendid spruce woods of Saxony, of which I have just spoken, are nearly all re-stocked by planting, and not by natural regeneration, although it is well known that spruce

is one of those trees which is easy to regenerate naturally. And you must have seen numerous instances on your visit to North Germany where planting, especially in coniferous woods, has been practised. The fact is that each of the two methods has its advantages and disadvantages, and it depends entirely on the local and special conditions with which you have to deal whether the one or the other is preferable. The principal points for consideration in this respect are the species to be grown, and the conditions of the locality. Where a tender species, like the beech or silver fir, is to be regenerated, which may suffer from frost or drought while young, a shelter-wood over the young crop is indicated. In these cases regeneration is generally effected naturally by the seed shed by the shelter-trees. But even this is not a necessity. The same, and in many cases even better results can be obtained by planting, and especially by sowing under and between the shelter-trees. For it is evident that the seed can be better cared for if placed by the hand of man, and the regeneration is likely to be more even, than if the distribution of seed is left to the accidents of nature. In the latter case sometimes two, three, and more seed-years must be awaited before a full new crop is secured, thus involving a serious loss of time. No doubt this is in some cases compensated for by a rapid increase of the volume and value of the shelter-trees, but this does not occur in all cases. In not a few cases, after having waited for a number of years without obtaining a new crop, or only a partial one, artificial regeneration has, after all, to step in and complete the crop, or even do the whole work. There can be no doubt that the successful conduct of natural regeneration under a shelter-wood requires the highest skill of the forester; and if the regeneration of a mixed wood is in question, the process may justly be called an "art," which only the greatest attention and skill can lead to a successful issue.

In the case of hardy species, especially if they are light-demanding from early youth onward, artificial regeneration is generally indicated, and leads to more satisfactory results than natural regeneration. Amongst this class of trees may be mentioned the larch, birch, Scots pine, and even the Weymouth pine, and in many cases also the spruce.

Then the soil, and specially the climate of a particular locality, have a decided influence upon the choice of method. Where the quality of the soil and the nature of the climate are unfavourable, a shelter-wood is indicated, so as to prevent a deterioration of the productive factors of the locality, or the springing up of a noxious growth of weeds. Where the climate is favourable, and especially where a too rapid drying up of the soil is not to be feared, as in most parts of this country, artificial regeneration may safely be resorted to. In this respect you will, no doubt, have found a decided difference between North Germany and Scotland. In this

country I should not hesitate for a single moment to regenerate larch, Scots pine, Weymouth, and even spruce by artificial means.

As to the compararive cost, it is generally asserted that sowing or planting requires a certain outlay, which is not necessary under natural regeneration, but it is only too frequently overlooked that under the latter process much time may be lost, and after all "*time is money*." Hence it cannot be said off-hand that the one method is cheaper than the other. Do not let me, however, be misunderstood. There are many cases in which I should adopt *natural regeneration*; all I mean to say is, that there are others, in which artificial renegeration is just as good, and not a few where it is better.

From the above remarks we are justified in concluding that there is no reason why just as good timber as that now imported from abroad should not be grown in this country, provided improved sylvicultural treatment and a systematic working of the forests are introduced.

Our Timber Imports.

The next subject, then, before me is to inquire whether there is a sufficiently large field open to us for extended action. An examination of the tables of imports and exports which are issued annually show that the nett imports represent a sum of money by no means to be despised. Taking, for instance, the returns for the years 1890-94, it will be seen that the average annual imports, including wood-pulp timber, came to 7,600,000 tons, representing a value of £19,000,000, of which sum about four millions went to the colonies and fifteen millions to foreign countries. By going back some years, it will also be seen that the average imports have increased by about £2,000,000 during the last eight years. Here, then, are facts which claim our attention, and we may well ask ourselves, whether, if not not the whole, at any rate, a considerable portion of that timber could not be produced, at paying rates, in this country? A detailed examination of the returns shows that, as far as the climate is concerned, about seventeen millions worth of the timber could be grown at home, leaving about two millions for timber which comes from species which have no chance of thriving in these islands. Of the 17 millions, no less than 14½ millions represent coniferous timber, while the other 2½ millions are made up by oak and other hard woods And what are these conifers? They are—(1) Baltic red pine, or our own Scots pine; (2) Baltic white pine, or the common spruce; (3) American white pine, the bulk of which consists of Weymouth, a tree which, introduced into this country about one hundred years ago, has been proved to be quite at home with us, yielding heavy crops of timber.

All this timber could be grown in these islands, and, as far as Scotland is concerned, the conifers would require special attention,

But have we the land for the purpose? To produce all the timber mentioned above, we should require at least five million acres. Are they available? A definite answer to this question could only be given after a detailed investigation, taking one county after another. But a general idea may be obtained by looking at the official Agricultural Returns. There we find that there are in the three kingdoms--(1) Waste land not used, about 13½ million acres; (2) mountains and heath lands used for rough grazing, 12½ million acres, making a total of 26 million acres. Of this area about one-half is situated in Scotland. No doubt a fair proportion of the waste lands could be used for afforestation, but it must not be overlooked that the greater part of it is unfit for the purpose. Taking both kinds of land together, I do not hesitate in saying that much more than five million acres are fit for afforestation. At the same time, we must remember that apart from rough grazing, by far the greater portion of the area is used for shooting, at any rate all that part which is fit for planting, and that shooting rents are high. I am told that they run from 6d. to 2s. 6d. and 3s. an acre. Hence these lands cannot be dealt with wholesale up here in the north. The income derived from shooting, including deer forests, is so considerable, that the proprietors are very touchy and suspicious in respect of anything that might affect this important source of income. Still, I am satisfied that, under proper arrangements, a considerable portion of the lands in question could be planted without interfering to an appreciable degree with shooting rents. In the case of deer forests especially, I believe that afforestation of the lower portions of the area would be likely to increase their value in this respect, while gradually an increasing revenue from the planted areas would be secured.

But I go a step further, by saying that in all cases where a proprietor is the owner of both land under wood and of waste land fit for planting, he can put a certain portion of the latter under forest without sacrificing a single shilling of his present income, while building up a higher rental in the future. I think it is worth my while explaining this by an example:—

Supposing a proprietor has 100 acres of woods, with a regular distribution of age gradations from 1 year up to 100 years old. In the ordinary way he would cut every year 1 acre of 100 years old wood, which would give him say, £75 income. Supposing he has now another 100 acres of waste land, which brings him 3s. an acre a year from grazing or shooting, or £15 a year, and he proposed to put it under wood in the course of 25 years; he would have to spend £3 an acre for planting or £12 a year. Let us also assume he has to sacrifice his grazing and shooting income at once over the whole area, so that he would have to find £27 every year. This he would find by cutting every year about 1½ acre of mature wood; in other words he would, during the 25 years, cut about 9 acres more than the ordinary area. In this way he would gradually press down his rotation from 100 to 91

years. On the other hand, he would have another 100 acres planted with young woods ranging from 1 to 25 years old. Then as the thinnings begin to yield some return, he would gradually reduce his cuttings of mature wood until he has raised the rotation again to 100 years, and from that moment he would enjoy a considerably enhanced income, because he would then cut over 2 acres every year, thus realising £135 a year instead of the previous £75. You will observe that I have based my example upon unfavourable conditions, because the owner need not lose the grazing or shooting rents all at once over the whole 100 acres. In this way a scheme could be worked out for every estate, according to its proper conditions.

Does it Pay to Plant?

But we must not forget to ask the question—Would it pay to plant? Great difficulty is experienced in getting hold of reliable data regarding the receipts and expenses of British woodlands. I have succeeded in securing these in a few instances, and they, coupled with my personal experience, as a practical wood manager, have enabled me to show that, here in the north, land which is capable of producing on an average $1\frac{1}{2}$ ton of coniferous timber per acre annually, can be profitably afforested if it does not yield an annual soil rental of more than 7s 6d. per acre. The calculation is made with $2\frac{1}{2}$ per cent. compound interest throughout and on the supposition that the thinnings are sold for pit props, and the final crop for construction, both at current rates. I shall of course, not weary you with further details of this question, but assure you that the calculation has been based on moderate expectations.

In this connection I should like to give you a few figures regarding the Saxon forests which I have already mentioned to you. The forests of Schwarzenberg have an area of 46,000 acres and are situated from 1000 to 2500 feet above sea-level. The annual yield from them is 3,640,000 cubic feet of wood of all kinds. Of this 3,045,000 cubic feet are timber, equivalent to 51 cubic feet English measure, by the quarter girth, per acre over the 46,000 acres of their area. The total receipts are £70,488, and the expenses are £24,239, leaving a net revenue of 20*s*. 1*d*. per acre. If you calculate out the price, you will find that it is not a high price they received for their timber. The woods are mostly of spruce, the trees having beautiful clean, cylindrical stems, 60 to 75 feet in height; but you will find that they only realise $4\frac{1}{2}$*d*. per cubic foot In Marienburg the price was a little better—the nett revenue being 27*s*. per acre.

It seems to me that, taking all these matters into consideration, as well as the fact that large and suitable areas are available for planting in Britain, a large sum of money might be kept in this country which is at present sent out of it for the commoner

kinds of timber, and that a strong case can be made out for extended action as regards the afforesation of waste lands in the country.

WHO IS TO PROVIDE FORESTRY EDUCATION?

Supposing now that we are all at one as to the need of improved forestry education, the first question is—Who is to provide it, whereby a staff of wood managers would gradually be educated, who are well versed in modern economic forest management?

The efforts of this Society and others interested in the matter have, up to date, been only partially successful, and the demand has gone forth of late that the State should do something to *further the business. A deputation of this Society had, as you* are aware, an interview some time ago with Mr. Long, the President of the Board of Agriculture, and the latter promised to see what he could do. This opens a question about which I should like to say a few words.

The State, as such, has, no doubt, duties to perform in respect of forestry, but its action must be limited by what is wanted in the interests and for the welfare of the nation as a whole. The nature and extent of the measures which the State should take in this respect depend chiefly on (1) the special requirements of the country; and (2) the nature of the proprietorship of the forests.

Where forests are required for their indirect effects, or where the means of import and of distribution over the country are deficient, the State might be called upon to interfere. But these cases do not apply to Great Britain and Ireland, at any rate, not at present. Generally speaking, these islands do not require forests for climate or similar reasons, and owing to their richness of coal, their sea-bound condition and extensive railway system, all parts of the country can be easily supplied from abroad. In this respect, then, State action could hardly be justified, *especially in a country like this*, where free trade and private enterprise are the very foundations of national life.

Referring now to the second point, I must mention that apart from about 100,000 acres of Crown forest lands, situated almost entirely in the southern half of England, there are no State forests. On the other hand, we have about 2,700.000 acres of private forests, and almost the whole of the 26,000,000 acres of land of which I spoke a few minutes ago belonging to private parties and not to the State. Hence it is to the proprietors that we must look for assistance in the first place, though the State should give a helping hand.

In this respect the action of Continental countries has sometimes been misunderstood. We have often seen it stated that France has two forest schools, and Germany some ten; but then the former country possesses upwards of 2,000,000 acres of State

forests, and upwards of 4,000,000 acres of forests belonging to communes, which are, by law, under the management of Government forest officers. Germany has some 11,000,000 acres of State forests, and about 6,000,000 acres of communal forests, managed by State forest officers. These forests represent a capital value of several hundred millions, and the revenue derived from them forms an important item in the State budget. It is, therefore, but natural that in these countries the Government should take care to give their forest employés the highest possible training in their profession, it having been recognised for a long time past that a high class training of the forest managers means a high return from the forests,

The Government of India, as you are aware, has for the last thirty years acted on the same principle, thanks to the enlightened views pressed upon that Gorvenment by Sir D. Brandis. That Government is the proprietor of more than 100,000,000 acres of State forests; and it has established two forest schools, one at Coopers Hill for the training of the European part of the staff, another at Dehra Dun, chiefly for the training of natives of India.

And yet instances are not wanting where private enterprise has done as well, and I cannot do better than refer you to the measures taken by the private forest proprietors of Bohemia and Moravia in Austria, who established the following forest schools:—

(1) Weissmasser, in 1855, by the Bohemian Forestry Society and taken over in 1862 by an Association of Landed Proprietors.

Graf Waldstein, Wartenberg, attached an area of 3000 acres of forest to the School for the practical instruction of the students.

(2) Eulenburg, in 1852, by the Moravian-Silesian Forestry Society.

(3) Lemberg, a similar institution, existing since 1874.

All three train forest managers for private woodlands.

(1) and (2) are entirely self-supporting; (3) has an annual grant from the State.

The above facts indicate that, as far as this country is concerned, we can expect only limited assistance from the State. Considering the large imports of timber, and a certain amount of uncertainty regarding future supplies, the State's action might reasonably be expected in the following four directions:—

(1) Assistance in the equipment of forest schools and training ground

(2) Management of, at any rate, a number of Crown forests on systematic economic principles.

(3) Advances at moderate interest (2½ per cent.) to landed proprietors who are desirous of planting.

(4) In some cases—for instance, where additional work is wanted in congested districts—surplus areas might be acquired and put under forest.

All the same time, we cannot close our eyes to the fact, that as the proprietors of forests are the people most interested in the systematic management of their woodlands, it rests, in the first place with them to afford the means for a proper education of their agents, if they really want it, though, of course, the State will do well to help.

Assuming this to be the case, why should we not be able to do as much as has been done, for instance, in Bohemia and Moravia? I do not expect any landed proprietor in this country to make a present of a large tract of Forest land, nor is this necessary; but would it be too much to expect that the proprietors should, between them, provide the means, towards the cost of forestry education in this country? Supposing, for the sake of argument, they determined to take up the matter in real earnest and to contribute *one* penny per acre of actual woodland annually, say for the next ten years, we should have for Scotland alone a sum of £3,600 a year, as there are some 900,000 acres of woods. And if only one-half of the proprietors joined such an association it would still have about £1,800 annually at it disposal, a sum quite sufficient to pay for the desired forestry education, apart from any help which the State may be willing to afford. Or if they only gave ½d. per acre, it would still be £900 a year. I am sure there is nothing so very startling in these proposals, which, after all, run on the same lines as those adopted in many other cases in this country. At any rate, they are thoroughly in accordance with the foundations of national life in Britain.

How is Forestry Education to be Arranged?

Assuming, then, that the necessary funds for a proper start became available, the next question would be—How the course of education should be arranged? Perhaps the best way of explaining my views on this point will be tell you shortly what we have done and are now doing at Coopers Hill College, and then to indicate my view as to what course should, in my opinion be followed to suit the requirements of this country.

More than thirty years ago, when Sir D. Brandis arranged for the education of candidates for the Indian Forest Department he informed the home authorities that as there were no forests in Britain managed on systematic economic principles, the training must be done on the continent. He arranged accordingly, that one-half of the candidates should be sent to France, and the other half to Germany. At the same time he suggested that some of the English Crown forests should be taken under systematic management, so that they might, in course of time, become available as training grounds for British forest students. Of the latter suggestion no notice was taken,

In the year 1883, when the Secretary of State for India had decided to start forestry education at Coopers Hill College, I induced the Government of India, in my capacity as Inspector General of Forests to the Government, to point out to the home authorities that, if forestry education in Britain were to become a living thing, the first step to be taken should be to place the principal Crown forests under systematic economic management. In making this proposal, both Sir D. Brandis and myself had in our minds' eye the idea that such a step would be beneficial, not only for the candidates of the Indian Forest Department, but also for students who wished to devote themselves to the management of forests in this country and in the colonies. However, for the second time, no notice was taken of the proposal, and a start was ordered to be made at Coopers Hill without proper training grounds in this country. When I was subsequently deputed to organise the forestry branch at Coopers Hill College, I had no choice but to propose that our students should go to the Continent for the principal parts of their practical training. Gradually, the arrangements were perfected, and they are now as follows ;—

Arrangements at Coopers Hill.

1. The students join the College in September, and remain under tuition for three years, divided into nine terms.

2. During the first seven terms they study at the College, being instructed in the auxiliary sciences, including Botany. and in the theory of forestry. During this time they visit all interesting forests in the vicinity of the College, one day a week being set aside for this purpose, and at the close of the first year they are taken for a fortnight to Brittany, principally to study the treatment of beech and oak woods, partly pure, but chiefly mixed with each other. In this way we enable the students to follow and understand the study of the theory of forestry. At the end of seven terms, the students are sent to Germany and placed in batches of two, with specially selected Prussian forest officers, under whom they work for five months, so as to see and learn to understand all the operations carried on in a well-arranged and well-managed forest district. Then they are all brought together, and under the guidance, until lately of Sir D. Brandis, and now of myself, they visit a selected number of specially interesting forest districts in South Germany. After that they are considered fit to be sent to India, and to enter the forest service of that country.

In arranging this course of study, we were guided by the following considerations :—(1) Theoretical and practical training

in forestry must go hand in hand; (2) the student must become thoroughly acquainted with the work in a systematically managed forest district; (3) the student must study varying conditions, over and above those found in any one district, so as to acquire a sufficiently ripe judgment, which will enable him to decide on the correct measures to be taken in any conditions which he may meet with subsequently in his work.

Before applying what I have said to the case of Scotland, I must clear the ground a little more. The demand for better forestry education has gone forth, but I have nowhere seen it clearly stated what is really wanted. There are a large number of foresters in Scotland who look after the woods on estates of varying extent. Some proprietors have only a few hundred acres, or even less, while others own areas up to many thousands of acres. The former employ a forester or woodman, whom they pay hardly more than any untrained industrious labourer can earn; and even in the case of the latter, the emoluments of their wood managers reach only a very moderate figure. Now, every labourer is worthy of his hire, and before a young man makes up his mind to devote several years of his life, and a not inconsiderable amount of cash, in acquiring a thorough knowledge of a profession, he must see his way towards obtaining afterwards a position and emoluments which make it worth his while to proceed. No man in his senses would go through a systematic course of study if all he could look forward to at the end of it, were a salary of say £70 a year. But then a proprietor will say—How can I afford to give more, if I have only a small area of wood to be looked after? The fact is that we require two distinct classes of foresters, the ordinary working forester, and the wood manager, or forest expert, if you like the term better. The former would be in charge of the ordinary current works, while the latter lays down the method of treatment, and supervises the execution of the work. Every proprietor would have one or a number of working foresters, according to the size of his woods, and a wood manager or a share of one. If his estate is of sufficient extent he will engage his own wood manager, and if he owns only a small area, he will secure the occasional services of one. There are endless examples where a land agent manages a number of estates, and there is no reason, as far as I can see, why the same should not be the case as regards wood managers. In that case they would secure an income commensurate with the sacrifices which they have made in educating themselves.

The working forester would be a practically trained man, who need not necessarily, at any rate not at present, visit a forest school, unless he desires to work himself up to the position of a wood manager. The future employés of the latter class require superior training. Unless you keep this distinction clearly in view, all your attempts are likely to lead to disappointment.

On looking over what has been done up to date, I find that there are three distinct means of acquiring a theoretical knowledge of forestry—(1) The training of working foresters at the Royal Botanic Garden, Edinburgh; (2) the lectures given in connection with the Department of Agriculture of the University of Edinburgh; and (3) those given in the Edinburgh School of Rural Economy. Over and above, I see it stated that it is intended to start forestry instruction at various other places.

Although I have considerable hesitation in expressing an opinion, owing to my incomplete knowledge of the local conditions, still as an outsider, I cannot help thinking that energy and money are likely to be wasted by running on too many lines all at once. For some time to come your chief energies should, in my humble opinion, be directed to the education of the future wood managers, while the working foresters will, for the present at any rate, do well to seek their training in well-managed forests.

In my opinion, you would do better if you, at the start, were to concentrate operations, so as to make *one* definite scheme a reality, and that scheme should be to perfect the education of your future wood managers or under whatever title they appear upon the scene. In other words I should advocate one centre of instruction, consisting of (1) theoretical instruction in connection with a university or agricultural college, where instruction in the auxiliary sciences is already provided; (2) woodlands where the practical instruction can be imparted, because in forestry theory and practice must go hand in hand.

As regards the first point,—theoretical instruction,—a beginning has been made in this very city, where my friend Colonel Bailey is delivering lectures on forestry. The arrangement needs only further development, and to be put on a proper footing, so as to bring the subject of forestry, as regards its importance, on a par with other branches of learning.

The difficulties are much greater in coming to the practical training, *viz.*, the provision of forest districts in which the practical part of the instruction can be conducted. To meet this difficulty, some members of this Society have proposed to start a model forest under the auspices of a joint-stock company. Now this is a novel idea, which at first sight may recommend itself to some people, but for myself, I confess I do not think much of it for several reasons. For one thing, the buying of a tract of land and planting it up would be equivalent to postponing progress for about another generation, during which time not much more could be learned in it, except what can be seen in hundreds of the forest estates existing in this country. For I need hardly point out to you that, as far as planting operations are concerned, our Scottish foresters may proudly enter the arena, never minding whom they meet therein. Indeed, in this respect, Continental foresters may learn a good deal by coming to Scotland.

For immediate use we require something more, and that is a

considerable area of actually existing forests, which can at once be placed under systematic management and regular sustained working. There is no necessity that these should at once be put into apple-pie order. All that is wanted is that a plan of operations, or a so-called working plan, should be drawn up for each, under which the forest (while safeguarding the interests of the proprietor) is gradually, and in the course of a number of years, led over into a model forest. There would be an annual return at once, which would gradually increase to the highest possible yield which could reasonably be expected from the area. Operations like those involved in such a conversion, would be the very thing for the instruction of students, and this all the more, as they would, when entering upon independent activity, in all probability have to introduce and conduct similar operations. Any forest area which is fairly stocked would therefore do for our purpose, provided it offers a sufficient variety of conditions. For the latter reason it would be best to have several forests, situated in different parts of the country. Now-a-days all parts are easily accessible, so that those estates could be conveniently reached, but it would be a distinct advantage if one of them was sufficiently close to the place where the theoretical instruction is given, so that it can be visited by the students in the course of a day, while at the others the students would pass through a regular apprenticeship.

Where are these Forest Estates to be Found?

As continuity of action, extending over a long period of time is required, nothing would be more proper than that the State should take up the matter; Crown forests should be used for the purpose. There are something like 100,000 acres of forests under the management of Her Majesty's Commissioners of Woods and Forests, who act under the control of the Lords of the Treasury. These forests are the property of the Crown, and they are leased to the State during Her Majesty's life. Whatever arrangements may be made hereafter, they represent areas in which the temporary wishes or necessities of the owner are not likely to interfere with the management, and they are therefore eminently fitted for continued systematic management. Unfortunately, none of these forests are situated in Scotland, but if we look at Great Britain as a whole, I think a renewed effort should be made to bring the principal Crown forests, in so far as they do not serve as Royal shooting grounds, under systematic economic management. I am inclined to think that the Commissioners of Woods and Forests would not be unwilling to consider any proposals in this respect, if it is made clear to them that systematic economic management does not mean cutting the woods down, but, on the contrary, leading them over into a condition in which they will give an increased yield and revenue.

There being no State forests in Scotland, I think the Government would not go out of its way if it were to buy an estate, a considerable proportion of which is already under wood, and to affiliate it with the Forestry School at the University of Edinburgh, with a duly qualified wood manager, in residence on the spot. This wood manager, under the advice of the Lecturer on Forestry and a duly constituted committee of control, would have to draw up a working plan of the area, giving full details of the objects to be aimed at, and the manner in which they will be realised. This area could at once be utilised for the practical illustration of many of the theories set fourth in the lecture-room, and it would also afford opportunty for the training of working foresters. Proposals for the establishment of such a training ground are, I understand, now before the President of the Board of Agriculture, and I trust he will see his way towards providing the means for the realisation.

But can we not achieve something more; could we not persuade a few, or even one, of the great landed proprietors of this country to make the experiment of placing their forests under systematic economic management? Let me assure them they need not fear for the æsthetic beauty of the estates. True forestry is not barbarous; on the contrary, the proprietors would soon find that their estates would be just as beautiful as before, besides improving in yield capacity and additional cash in their pockets. Nor need forestry interfere with the income from shooting, at least not more than what would be fully covered by additional receipts derived from the sale of forest produced. Of course we must not forget that this is a century which marches ahead at a quick pace, while forestry is an industry which proceeds but slowly. Haste has no place in forestry. Still there is no reason whatever to doubt, as I have already shown, that an estate can be subjected to systematic forest management without curtailing the revenue hitherto derived from it, while giving promise of a considerably higher revenue in the future. At the outset, occasional visits to suitable Continental districts would probably be necessary, but they may be reduced in the same degree as the systematic management of the home estates improves, until they would become unnecessary. The sooner the latter stage is arrived at the better, because, apart from political considerations, these visits are a source of great inconvenience and expense.

And now, gentlemen, I fear I have kept you long enough. The subject of forestry education is one in which I take a great interest and I only trust that the realisation of your aims in this respect may be accomplished at an early date. National and private interests of considerable magnitude are involved in their realisation, which I hope will not be put back for another generation.

Equilibrium between the Crown and the Roots of Trees.

On this subject M. P. Fossier has a useful article in the *Revue des Eaux et Forêts* for May last, which should be read in connection with the important researches of M. Henry on the covering of the soil, and of MM. Bartet, Watier, and others, which have been lately discussed in the *Indian Forester*. It is pointed out that the increment is not affected only by the covering and quality of the soil, but that in order to obtain a just appreciation of the facts, it is necessary to look at the tree from head to foot. Doctors are fond of certifying, for due consideration received, that one teaspoonful of Jones' Mustardine contains more nutriment than 14 lbs. of best mutton, but they do not certify, as they would, if Mr. Jones desired it, that this redundancy of nutriment is nearly all wasted because of the inability of the consumer to assimilate it. So with a tree, it is no use burying the roots in rich and concentrated food, unless the other organs of the tree are able to work at a high enough pressure to utilise it. If the man's other organs are feeble, or his surroundings uncomfortable, or his nature discontented, he simply gets indigestion. Trees are not always contented with their surroundings, and though there is no proof that they suffer from any active kind of indigestion so far as *quantity* is concerned, yet the nutriment, for all the good it does, might as beneficially be passed through a sieve as through their tissues.

M. Bartet's experiments, during the 30 years cycle in the life of a standard over coppice showed that in spite of the continual increase in the covering of the soil, the thickness of the annual rings and ultimately their area, becomes less and less. This fact has been, somewhat unnecessarily, a stumbling block to some As M. Fossier neatly puts it, there is nothing like the open air to give one an appetite, and without appetite there is poor digestion. It is evident that a standard over coppice has, at the

end of the 30 years coppice-cycle, much less of the open air, and consequently much less reason to be contented with its surroundings, than it had at the beginning, when the coppice had just been cut. It has less room, less light and heat, its leaves are fewer and work less actively, its lower branches suppressed. It is thus quite natural that although the tree continually becomes larger, yet the increments may remains stationary or even diminish. Take a tree for instance, growing in close canopy. Its crown, its root space, its light, are approximately constant, and the increment is therefore nearly constant in volume. But as this tree increases in size, the constant increment is being spread over larger and larger areas, consequently the annual ring must be thinner, and it may even appear, incorrectly, that the tree is on its decline.

There is a constant natural tendency, necessarily so, towards the establishment and maintenance of equilibrium between the crown and the roots. When a coppice is cut, the crowns of the standards suddenly find available an almost unlimited supply of light and heat. The air becomes drier and is more in movement. All these conditions provoke the buds to develop and the leaves to assume their utmost activity in transforming the raw sap received from the roots into wood. The consequence is a great development of the crown, as shown by M. Watier's experiments published in France in October, November, 1896. But the activity of the crown provokes and necessitates a corresponding activity of the roots, strictly in proportion. The equilibrium is being annually and incessantly disturbed and re-established throughout the life of the tree, only at a coppice felling the disturbance is great and sudden. There is nothing to prevent the expansion of the crowns, except the capacity of the root system, and the roots are also able to develop and spread because the roots of the stems that have been cut or coppiced are no longer in a condition to compete with them, having few or no leaves to second their efforts. In the case of these stumps, the equilibrium has been absolutely destroyed, and it requires some years before they are at all in a condition to resume the struggle. It is thus clearly explained how, in spite of the impoverishment of the soil caused by the felling, the vegetation of the standards is actually at this period superior to what it is when the soil has recovered its best qualities, how it is in fact, as recorded by M. Bartet, that the growth of the standards is in *inverse* proportion to the quality of the soil in a coppice.

The period, during which the standards are absolute and undisputed masters of the situation, varies with the species, locality, &c., and can be ascertained by every forester for himself. Merely as an example, may be quoted the forest of Montdieu, in the Ardennes. Here, the period is, for oak, 7 or 8 years, for soft woods, 8 or 10 years, for beech and hornbeam 5 or 6 years. There are oaks in this forest which at the age of 100 years attain a girth of 3 metres and contain 20 to 22 cubic metres of useful

timber. One of these trees, of moderate size, was measured. Its girth was 230 centimetres at breast high, and it contained 15 cubic metres of useful timber. Its age was 103 years, during which period it had been isolated 3 times. The mean radii measured at the stump were: at the first isolation, when it was 18 *years old, 6 centimetres; at the second isolation, when it was* 43 years old, 13 centimetres; at the third isolation, at 73 years old, 26 centimetres; and when cut at the age of 103 years, 45 centimetres. The following table shows the thickness and area of the annual rings, by periods of 5, 7, and 8 years these being the periods for which the variation was obvious on the stumps.

	Period.	Thickness of annual ring, millimetres.	Area of annual ring of square centimetres.
age	14 to 18 years	5·4	15·78
,,	19—23 ,,	9·4	49·32
,,	24—28 ,,	5·2	34·92
	37—43	6·4	64·34
	44—50	8·3	82·77
	51—56	5·7	74·68
	66—73	6·5	83·78
	74—81	9·0	179·16
	82—89	6·1	137·19

Why does this period of rapid growth, cease almost as rapidly as it began? Why does the growth, so to speak, flare up and then die down to the normal and average level?

M. Guinier says that "in a given climate, the amount of light "is one of the factors of the soil-fertility." After the period of 5—10 years, the cover being again nearly complete, little light can reach the soil, the fertility of which consequently reverts to its normal level. M. Mathey says that "when a tree is freed "from the surrounding canopy, it first spreads its branches, and "then develops quantities of flowers and fruit. These require "considerable physiological efforts and absorb large quantities of "nutriment, leaving little for the increment in wood."

M. Fossier thinks that an additional reason may be found. After the felling, the accumulated richness of the soil is rapidly used up, the fallen leaves decompose more rapidly and are absorbed, while the newly falling leaves, though continually increasing in quantity, cannot, as the cover increases, decompose so rapidly as before. Hence, though the covering of the soil becomes thicker, it is in a less rapidly assimilable state. Probably all three causes have their share in the result.

F. GLEADOW.

Report on some Indian Gums.

The gums which have been examined are described in a letter from Dr George Watt to Mr. Royle, dated the 2nd June 1896, which enclosed a copy of a Memorandum, *No. 286, dated 29th* June 1895, from Mr. Gamble. Conservator of Forests, School Circle, North-Western Provincesand Oudh, on the subject. Mr. Gamble stated that the local demand for the following gums, which are procurable in the forests of the Saharanpur Divison, is not very good, and that it would be advantageous if new and better markets could be found for such products. At present the supply is limited, but if new markets could be found, the supply of certain kinds, especially those of Jingan and Pial, could be greatly increased.

Four samples were received :—

1. Semla (*Bauhinia retusa*) gum.
2. Jingan (*Odina Wodier*) gum.
3. Pial (*Buchmania latifolia*) gum.
4. Salbar (*Boswellia serrata*) gum.

The following is an account of the chemical examination of these samples :—

Bauchinia retusa.—The sample consisted of large rounded tears and irregular masses, together with small angular fragments. The tears were opaque, brittle, breaking with a vitreous fracture, and brown in colour. The fragments were translucent and varied in colour from yellow to brown. The taste was bland and mucilaginous, though the gum was not very soluble in the mouth. The percentage of moisture in the natural gum was 13·5, and of ash in the dried gum 3·18. When the gum was mixed with twice its weight of water, it swelled up, absorbing the whole of the water, and forming a stiff gelatinous mass. It absorbed in this way six or eight times its weight of water. A 10 per cent. solution, made for determining its comparative viscosity, yielded a thick mucilage which could not be manipulated. A 5 per cent. solution was therefore employed. Even with this amount of water, a considerable quantity of the gum remained insoluble, swelling up and forming a gelatinous mass. This jelly was removed by straining through muslin, and the viscosity of the mucilage determined *(see below)*. The solution gave the usual reactions of gum acacia and only very faintly reduced Fehling's solution. With iodine no colour was given, showing the absence of starch and dextrine. Though resembling gum arabic in some of its properties, this gum is more like tragacanth in its behaviour to water. It possesses considerable gelatinising power.

Odina Wodier.—The specimen consisted of small rounded tears and angular fragments, with a few large irregular masses. The tears were opaque and fissured, the fragments translucent, the gum had very little taste, and varied from white to yellowish white in colour. The gum contained 12·3 per cent. of moisture, and the ash in the dried gum amounted to 3·73 per cent. The gum was completely soluble in twice its weight of water, forming a rather thin mucilage which possessed considerable adhesive power. The viscosity of the mucilage, compared with good gum arabic, is given in the Appendix. The watery solution answered the ordinary tests for gum arabic, except that it had a marked reducing action on Fehling's solution, indicating the presence of a sugar. A solution made with boiling water and cooled was unaffected by iodine, showing the absence of starch and similar constituents.

Buchanania latifolia.—The gum occurred in large irregular massses, tears, and small fragments. The fragments were clear and glassy, as aslo were the larger masses. The latter contained considerable quantities of impurity, in the shape of pieces of bark, &c., and the whole sample was contaminated with vegetable débris. The gum had little taste, and the fragments varied in colour from yellow to reddish brown. The amount of moisture present in the gum was 14·2 per cent., and the ash, calculated from the dried gum, amounted to 6·27 per cent. The gum was not entirely soluble when mixed with twice its weight of water, a portion swelling up, forming a gelatinous mass, which remained undissolved. When making the solution for the viscosity determination, the quantity of this insoluble portion was roughly estimated and found to be about 10 per cent. The mucilage obtained by treating the gum with twice its weight of water was thick, and possessed strong adhesive properties; it behaved like ordinary gum arabic, contained no starch, but a small quantity of sugar was detected.

COMPARATIVE DETERMINATIONS OF VISCOSITY.

The viscosity of the solutions yielded by these gums, compared with that of a solution of the best gum arabic, was approximately determined by noting the time taken by 50 c. c. of a 10 per cent. solution to run from a burette fitted with a fine jet. In the case of the gum from *Bauhinia retusa* a 5 per cent. solution was employed. The following table gives the results obtained :—

	Strength.	Burette time in seconds
Gum arabic	... 10 per cent.	... 78
Odina Wodier	... 10 ,,	... 58
Buchanania latifolia	... 10 ,,	... 184
Bauhinia retusa	... 5 ,,	... 200

It appears from these approximate results that a solution of the gum from *Odina Wodier* possesses about three-fourths of the viscosity of a similar solution of gum arabic, that of the gum from *Buchanania latifolia* is more than twice, and that from *Bauhinia retusa* nearly eight times as viscous as gum arabic solution of the same strength.

The only previously recorded examination of these gums seems to be that by Dr. Rideal in 1892 (Journal of the Society of Chemical Industry, Volume II.), who was furnished with small samples by Professor Pedler of Calcutta. Although it is evident from the preliminary results recorded by Dr. Rideal that the gums examined by him were the same in origin as those now under notice, it is obvious that their quality is different and usually inferior. It is important that attention should be paid in the future to the exportation of gum of uniform quality.

Boswellia serrata.—This is a gum of an entirely different class. It closely resembles frankincense in its chemical properties. There is little demand for such a product in this country, but it might find a market on the Continent as an ingredient for incense.

Since the commercial value of the gums of the Acacia type must depend on other circumstances than those connected with their chemical properties, as, for example, colour, size, freedom from contamination with extraneous substances, &c., it was thought desirable to obtain the opinions of several of the best known London dealers in gums. They were each supplied with small representative samples of the three gums, and were asked to furnish a report on their probable commercial value. The four reports which have been received may be summarised as follows:—

1. These brokers report that *Odina Wodier*, chiefly on account of its solubility, would be the most readily saleable. The less soluble varieties, *Bauhinia retusa* and *Buchanania latifolia* they consider of small value, as large quantities of similar gums are received in this country from Persia. They are chiefly bought by Continental dealers, and are said to be treated by some special process and rendered soluble. Prices for these inferior gums not large,—from 10*s*. to 20*s*. per hundredweight.

2. The brokers report that there is on the English market a large quantity of all kinds of East Indian gums, which renders it very difficult to dispose of inferior qualities. The only sample which they consider would command a free market is that of *Odina Wodier*. With reference to *Banhinia retusa*, it is remarked that this gum closely resembles Persian or Bassorah gum, but it is not considered to possess at the present time any commercial value. *Odina Wodier* is compared with Cape gum, and, like it, might be used for preparing pale-coloured mucilages, and for mixing with gum acacia to reduce the cost of the latter. Its value is stated to be between 25*s* and 30*s*, per hundredweight. *Buchanania latifolia* is described as a gum of inferior quality only partially soluble, containing a large quantity of extraneous

matter. It might be useful for cheap manufacturing purposes where the dark colour would not be detrimental. It is likely to fetch 20*s* per hundredweight. These brokers remark that it is desirable, when introducing a new gum, to ship it in large quantities of not less than, say, 5 tons, as English consumers will not trouble to substitute new gums unless they are certain of obtaining a constant supply of average quality.

3. The brokers report that all the samples are of inferior quality. *Bauhinia retusa* is probably worth 15*s* to 20*s* per hundredweight. *Odina Wodier*, which they remark has been carelessly collected and is largely mixed with earthy matter and wood, would fetch from 20*s* to 25*s* per hundredweight. *Buchanania latifolia* they report to be of little value.

4. *Buchanania latifolia* is stated to be too insoluble to be of much value. *Bauhinia retusa* is inferior gum worth about 10*s* per hundredweight. *Odina Wodier* is the most valuable of the three samples submitted, but its appearance is much against it. If a constant supply could be obtained, and if more care be taken in collecting it, it could probably be sold at from 30*s* to 35*s* per hundredweight.

It will be seen from these commercial reports, that it would be worth while to pay some attention to the exportation of *Odina Wodier*, but it would evidently be necessary to take greater care in the collection of the gum, and to avoid the inclusion of extraneous matter. It would probably be desirable to pick out the better pieces which are nearly free from colour, and send them as a separate consignment of first quality, the coloured and contaminated fragments being included in a separate consignment of second quality. It also appears that *Buchanania latifolia* might be worth exporting if greater care were taken in its collection and especially if large quantities of slightly coloured fragments could be put on the market. One firm of brokers who reported on the samples, offered te take charge and dispose of any consignments of these gums which may be sent to this country.

WYNDHAM R. DUNSTAN,

Director, Scientific Department,

Imperial Institute.

2nd February, 1897.

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V—SHIKAR AND TRAVEL.

A Day on the Beas.

Towards the middle of last March a very well-known forest officer, whom we will call A, came down in this direction to visit the famous, or rather infamous, Hoshiarpur Chos, and after we had seen them and marched through the Lohara forests, we made our way down to the Hoshiarpur bamboo forests by river instead of going along by the road. To give a complete account of the trip would occupy too much space and would also not be particularly interesting, for like so many fishing excursions, it was mainly a case of unfavourable conditions and bad luck which all our ingenuity was unable to conquer, though a fish came along now and then just to keep us from utter despondency. Still, when we started on the morning of the day that was to retrieve our fortunes, we were not so very far off that undesirable condition; as for the previous two days we had been on the very best water in the river, the place where each of us had confidently hoped for that monster fish, which it is always the fisherman's ambition to catch, and which in ninety-nine cases out of a hundred, he never gets. The water I have referred to consisted of two long, slow and very deep pools with a nice run between them, the head of the lower pool and the run could be fished by wading out from the bank, the latter with a fly spoon and the former with a spinning bait, but the rest and greater portion of the water could only be worked by that abominable method known as 'chukkering' from a 'sarnai.' Neither of us had ever fished the Beas or tried this particular game before, and we came to the unanimous conclusion that it was the most uninteresting and tiresome method of catching fish, or rather trying to catch fish, that we had ever attempted. There is undoubtedly a certain amount of skill required in manœuvering to get out a long line below you and then in keeping your spoon, which is the only possible bait for this style of

fishing, off the bottom of the river ; but do what you will, your spoon spends a good deal of its time reclining pleacefully on the bottom and you spend most of yours in adjuring the sarnai men to keep you moving up stream or at least prevent you from running down on to your spoon. We chukkered and chukkered until we gave it up in disgust although the local men told us that never before in the memory of man had any sahibs left this water without fish, and pointed to an overhanging rock in the lower pool on which was drawn the outline of a sixty-five pound monster that a famons Beas fisherman had caught some years ago. Our failure however was not altogether surprising, for on the first day we were afflicted with such a storm of wind, that we were smothered and almost choked with sand and our sarnais blown into the rocks, under which we were only too glad to shelter until a lull in the storm let us get back to camp, breakfast and office. A tip that may be useful to anyone fishing in this style from a sarnai, is to have out the centre third of the charpai netting and sit with your feet hanging down in the water ; or if you wish to keep dry, have a little wooden well made of such a depth that it just keeps clear of the water. If you are inclined to be still more luxurious, have a back made to the charpai ; then you can chukker in comparative ease and comfort, though, as I have said before, it is a poor game at the best of times, and one of its greatest disadvantages is the awful disturbance made in the water by the splashing and kicking of the men in trying to keep the unwieldy machine from travelling down stream.

The 20th of March was to take us down the river from Sithána to Ray and then in the evening across to the forest bungalow at Pandain. So about half part seven we embarked on our sarnais, hopeful as ever, but hardly expectant, for we knew that the river split up into several branches below us, and were told that we had left all the best of the water behind us. Till well on towards midday we neither of us touched a fish, and I may say here that we never did do anything in the morning and that nearly all our fish were caught in the middle of the day and the afternoon, probably because it was unusually cold and stormy for the time of year. About midday, however, I changed the spoon for a phantom, for natural bait was not procurable, and shortly had a small fish, and not long afterwards came on a good pool just below the junction of two large branches of the river with another small and shallow branch running into the middle of it, deep and with a nice stream throughout, this seemed to me to be just the place for fish, so I landed and started spinning a leaded phantom a little above where the small branch came in and just as I got to the edge of this had another little fish. A couple of casts afterwards I was on to something quite different. A fish that grabbed the phantom with a blow that pulled the point of the rod down almost to the water and that then, instead of going off

with a big rush, hung in the stream and allowed me to coax him towards the shore, until suddenly realizing that something was wrong, he turned and went off down stream with such a rush that I thought he would bring me to the end of my hundred and fifty yards of line, an experience which having once had happen to me on the Jumna, I did not desire to have repeated. Down stream he took me, coming in gradually and then going off again with a run into the middle of the pool several times before he was too done to resist the steady pressure of the rod any longer, and had perforce to submit to being landed. Thirty two pounds was his or rather her weight, and I was somewhat lucky to land her as she had succeeded in breaking two out of the three mounts on the phantom. Back I came to the same place and shortly had a nice little eight pounder who fought like a fiend and then after one more offer from what seemed to be a good fish, and I was off down *stream to overtake A—who had in the meantime been fishing at* the head of the next pool, a small one, from which he had succeeded in taking five small fish on the spoon. Hearing of my luck he too put up a phantom and started down the next long pool while I went straight through and found some more nice water below, but only small fish. In one place where the water came tumbling in over some rocks a little chap had the phantom almost as it touched the surface and then jumped clean out of the water, a thing that I have only once or twice previously seen a Mahseer do. A second little fish here and I went on to where another branch of the river came into the pool ; but this one came tearing down a steep bed and was too strong to wade across, so I had to be content with getting as far into it as I could, casting out into the strong stream and playing the phantom in it. Four more small fish I took here and had perhaps twice as many runs for the water was very strong and the fish did not seem to be able to get a fair hold of the phantom, very possibly they could not see it very clearly. Here too I met with an accident to my tackle, for a little beast of a fish went off with a brand new phantom, through the breaking of the single wire trace, when the fish was within a couple of feet of the bank. To be broken by a good fish is all in the day's work, but to be broken by a little three pounder is more than aggravating and I am afraid that single wire came in for no little abuse. It is, I believe, a good deal used for trolling for salmon in Lock Tay and for that purpose is undoubtedly excellent as it withstands almost any direct strain, but I do not think it is reliable for casting ; at any rate it has sold me several times and I prefer to use the Hercules wire gimp, which though a little more expensive, is wonderfully strong and flexible and never kinks. While I was engaged in putting my tackle to rights, one of A—'s men came down from the pool above with a request for the loan of the weighing machine and said that A——— had got a big fish, and after a little while he brought the spring balance back with the information that the fish scaled

thirty five pounds. Shortly after A—— —himself came down and we had a general inspection of the spoil, and when we had fully admired our two big fish which matched each other beautifully, we voted an adjournment for tiffin for it was nearly four o'clock, we had had nothing since our early breakfast and were quite ready to investigate the contents of the luncheon basket. Thereafter we got no more fish and so dropped quietly down the river the remaining short distance to Ray, where the horses were in waiting to take us across the three miles to Pandain. We were very wet and fairly tired, but still the ride was a pleasant one for we had the day's experiences to discuss, and though the bag, **17** fish and 109 pounds, was nothing out of the common, neither of us had ever caught quite as big a fish before, and so we agreed that *the results made up for our previous ill luck, even for that chukkering* at Sithána.

It may be interesting to some fishermen, if I note in conclusion, that the results of our trip fully corroborated previous experience as to the advantages to be gained by using a Malloch spinning reel. We both had these reels and found them work very satisfactorily. In anything but quite slack water, the spin produced by winding in is quite sufficient, while the distance you can cast with one of these reels is certainly one and a half times as great as that to be obtained with an ordinary reel and any of the customary methods of coiling the line on the ground or round the hand. There is no bother with a kinking line and none of that exasperating fouling of the line round stones and sticks. Being able to cast further, you can keep farther away from the water you wish to fish, while finally, and probably greatest advantage of all, you can wade as deep as you please and still cast as far as ever.

X.

On the choice of Rifles for the use of Forest Officers.

A fitful correspondence flickers in sporting papers regarding the comparative merits of various rifles, each sportsman swears by that weapon with which he has made a successful shot or series of shots and few of them recognize that in circumstances however slightly altered, their joy might have turned into grief. In fact, each views the case from a different stand point and to the inexperienced reader some confusion of ideas is inevitable. It has often occurred to me that with the experience I now possess I might, during the past 25 years have saved much coin expended in trying various rifles and also, at the same time, have increased my bag of large game, and it may therefore be worth the while of the

more junior members of the Department to consider the subject of rifles from a Forest Officer's point of view. The possession of many rifles is a weariness to the flesh. Want of practice causes one to shoot badly with all, and one never has the weapon one requires to hand at the right moment; but the owner of two good rifles should be able to pass his service, varying between the denser jungle of the plains and the breezy heights of India's mountain ranges, with the maximium of satisfaction to himself and the minimum total expenditure in armament. We will consider how these objects can best be attained.

As before hinted, I have possessed many—far too many—rifles; from the double barrel 8-bore weighing 17 lbs. to the latest small-bore with smokeless powder, including expresses of all calibres; but I have never yet succeeded in procuring one weapon which would meet every emergency. On some occasions it is imperative *that we should produce the shock of a knock-down blow, in others* we require penetration; sometimes external accuracy at large ranges is necessary, or again so long as we can hit a six inch bull at a few yards distance, we ask nothing more. The rifle which is guaranteed to attain all these results, and perhaps others, will in practice probably be found to be a sorry makeshift at all times.

We may, for convenience sake, classify rifles under three heads: large bores, Expresses and small bores; the former comprises rifles from 4 to 12 bore; the second those from ·577 to ·360; and the third rifles from ·303 to ·250 firing smokeless powder. The first class of rifle is essentially a luxury to the ordinary, Forest Officer. To be effective they must be heavy and therefore unwieldy to a certain extent; they are useful only to take the first shot at very heavy game or to meet its charge at close distances. For the former purpose, a lighter rifle may be found which is equally effective, and being more accurate, allows the sportsman to take his opening shot at greater distances, thus running less risk of disturbing the game and giving more chance for selection of a suitable shot. In the case of the hunter being hunted, if a large bore is *thought indispensable*, a *Paradox* or smooth bore gun of the same calibre would have an effect equal to that of the rifle and would be useful for other purposes than the sole object of propelling a solid mass of lead. As an example, the service M. H. rifle with its ounce bullet and three drams of black or equivalent of smokeless powder, is a most effective weapon for the first shot at distances within 100 yards at bison, rhino and elephant; whilst if compelled subsequently to face the wounded animal, a smooth bore is good enough for distances up to 50 yards: and beyond that range, leisure might be found again to utilize the accuracy and penetration of the M. H. with final results. It is not therefore proposed to discuss the varieties and uses of large bore rifles but to pass on to Expresses so-called.

In an Express rifle, in order to ensure a certain minimum muzzle velocity, the weight of the charge of black powder must be at least one-third of that of the bullet. This necessitates the use either of an inordinate charge of powder (sometimes so large that it cannot all be consumed in the barrel) or of a light bullet; and, as a rule, this bullet is so constructed that it breaks up on impact and thus sacrifices penetration to shock. The immense advantage of rifles of this description is that the less trajectory obviates the necessity of accuracy in judging distances; the disadvantages are recoil, noise, blinding smoke and uncertainty at distances over 200 yards. Moreover, owing to the high speed of the bullet and its shape, deflection on encountering the slightest opposition is frequent; and lastly there is great want of penetration. It is true that in these days, Express rifles are constructed to shoot two entirely different types of bullet, a heavy long range and a lighter short range projectile; but, bearing in mind that a high class double rifle is thrown off its shooting by the slightest variation in loading, it may well be doubted if all the merits claimed for this type of weapon are proven.

The smaller the bore of the Express the higher the velocity of the bullet but the less momentum; hence both shock and penetration fall off in the smaller bores and for the Forest Officer there are only two or three rifles of this class worthy of consideration, *viz*: the ·500 and ·577 bores. The smaller Expresses are beautiful weapons, but the ordinary mortal when placed in trying circumstances does not shoot sufficiently accurately to make it worth his while to risk his life on the chance of stopping dangerous game with a ·360 ·400 or ·450 bullet. With harmless animals again, any failure to locate the small projectiles in exactly the right place may cause the loss of a much coveted trophy. These small Expresses need not therefore be classified as Forest Rifles.

The ·500 Express on the other hand is a good all round weapon up to a certain point. For a body shot at all thin-skinned game it answers it purpose well; but it is not a bone-crusher nor is it of much account in a facing shot. The writer has possessed a rifle of this class by Henry for over 20 years, and has killed therewith hundreds of head of large game, but must confess that he has also lost an unnecessary large number, and has been once or twice placed in inconvenient surroundings, owing to want of penetrating power in the bullet and insufficiency of shock imparted. Especially in the case of animals whose massive bones are covered with layers of elastic muscle, is the ·500 Express unsatisfactory; the bullet expands to the fullest extent in the muscle and is reduced to powder in the bone without causing serious injury. Such a wound inflicted in a big tiger, though it may for the moment roll the animal over, often results in causing a frenzy of fury which may become decidedly unpleasant. When hunting a tiger single handed with a ·500 Express, great care should be taken to ascertain accurately where the bullets have struck; an animal hit forward

of the stomach at right angles to the spine, or at an acute angle to it from behind, will either drop dead within a few yards or at any rate halt and die after a short time. He may leave the locality as hurriedly, if the wound is only superficial, and it is therefore well to be fairly certain of what has happened before proceeding to verify one's opinion. To fire with a ·500 Express at a facing tiger is, save in exceptional cases, to be avoided; it may be dangerous to the shooter and it will certainly spoil the tiger. Owing to the angles at which a tiger's head is held, the conical bullet will most probably glance on the skull and the best chance of bagging the beast is to hold low at the junction of neck and chest and trust to luck for penetration to the vitals. It is, however, just as likely that the bullet will pass outside the cavity of the chest without inflicting mortal injuries. One can never predict with even fair certainty what the effect of a conical hollow-fronted bullet travelling at high speed will be, because it behaves entirely differently with each change in circumstances; with one shot you may drill a hole through a buffalo's forehead, with the next the bullet may break up on a deer's haunch, inflicting a ghastly wound and condemning the unfortunate animal to lingering death: but generally speaking, the effect produced is primarily dependent on the angle of impact, the acuter the angle the less probability of the infliction of a serious wound.

The ·577 Express is the only rifle of this class with a powder charge and weight of bullet capable theoretically of overcoming the momentum of a charging tiger. There is much comfort in this thought, and there can be no good shooting without confidence. The heavier bullet and lower muzzle velocity also ensures greater penetration and though the use of the hollow-fronted bullet is primarily open to the same objections in this bore as in the ·500, yet its effect when properly used is much greater, and by substituting a solid bullet of soft lead, we ensure penetration with sufficient shock to knock all soft-skinned game out of time. Such a bullet will travel from throat to haunch of a tiger, or pass through both shoulders to be found flattened under the skin on the other side; whilst the hollow fronted bullet will, if placed anywhere in the body, induce death in a comparatively short time. The ·577 Express, however, presents the disadvantages of weight, recoil, noise and smoke, to a greater degree than the ·500; its range of accuracy is less; it is essentially a weapon for use for distances within 100 yds. when in spite of these drawbacks it is, if properly handled, the most effective forest rifle for large game at present in existence, it is handier than a larger bore rifle and will produce equal results. The makers of smokeless powders now advertize cartridges for Express rifles loaded with their compounds. The effects of these powders in small bore rifles are often so unexpected, that until they are more fully regulated, I prefer not to fire large charges save in weapons specially constructed of enormous strength in order to resist any unforeseen

influences which may be brought to bear in these sensitive compounds.

Whatever rifle the Forest officer may possess in the more serious pursuit of game, he will still wish to have a weapon to be the companion of his lighter moments, to keep his hand and eye in training, to provide venison and fowl for his household. For everyday use he will probably select a ·303 or ·256 bore, he will probably waver between a double or single barrel with or without Magazine attachment. A good double barrel rifle will cost about four times as much as a single barrel, and as at present made it will not be accurate much over 300 yards; whilst the effective range of the small barrel will be 3 or 4 times that distance. With a single barrel, 10 aimed shots can be fired in a minute; not much more can be done with a double barrel, so that the sole advantage in the case of the latter appears to be the celerity with which the second shot can be put in. As for magazine attachments, apart from the fact that they sometimes refuse to work, and the objectionable rattle of the action, their most serious drawback is that any alteration of the length of the bullet, often necessary in order to vary the extent of penetration, is too liable to cause difficulties in the passage of the cartridge from magazine to chamber.

The writer advocates the use of a single barrel, ·303 bore rifle, because in the first place it will shoot Government and other service ammunition in an emergency; secondly, because the cleaning of the barrel is easier in the larger bore, and lastly because by the simple insertion of a Morris tube, excellent practice can be obtained without expenditure of expensive cartridges. The use of a nosed solid bullet propelled by Rifleite is also suggested; that powder is clean and fairly uniform whilst the behaviour of the bullet is constant. The same cannot be said of other bullets where break—up on impact is ensured by weakening by various methods the nickel envelope at top and sides. Examination of such bullets will disclose the fact that the process employed is most irregular in results and it becomes evident, without going to the vexation of practical test, that the behaviour of the missiles must also be extremely various. The soft-nose bullet expands in impact and is reduced to powder on continued resistance being met. It passes through the bodies of small deer, and its fullest effect is obtained when used on the larger deer, where resistance is sufficiently prolonged to cause the destruction of the bullet. The extreme handiness and accuracy of the ·303 make is an invaluable weapon against all kinds of non-dangerous game, but these advantages are, of course, discounted by the smallness of the wound and inferiority of shock in comparison with larger rifles. The smaller the bore the finer shooting is required and those who think that with the ·303 any shot will be effective will be grievously disappointed and had better retain the less accurate but more powerful Express. As a weapon for stopping dangerous game the ·303 is futile, the shape

of bullet is against the chance of a facing shot being effective and the shock imparted is only about one half of that communicated by a ·577 Express bullet. When shooting from howdahs, surrounded by a crowd of friends and dependents, any rifle is good enough for dangerous game. It is called sport when a beast, maddened by careless shooting with unsuitable weapons, makes ineffectual efforts to retaliate on his butchers ; but when the chances are more equalized, that weapon is best which will enable the sportsman at once and finally to take advantage of the opportunity which his courage or knowledge of woodcraft has afforded him.

Had the writer again to pass half a life time in an Indian forest, he would consider himself adequately armed if he possessed a double barrel ·577 Express and a single barrel ·303 rifle, and that whether located in hills or plains. He would have these two rifles stocked and balanced exactly alike and, more important still, the pull off should be the same. The addition of any other rifle, save perhaps a service M. H. Carbine, he would hold to be a luxury of somewhat doubtful value tending to reduce that degree of familiarity with ones' weapons which is essential to all good shooting. A knowledge of the capabilities of these two weapons and of the effect of the bullets they carry, is sufficient to give confidence in the pursuit of large game, provided care is taken to locate the first shot in approximately the right place, and that precautions are taken to prevent undue advantage being taken of the hunter. Most accidents and ill success in big game shooting arise from neglecting one or other of these two important considerations and a whole battery of heavy rifles will not lessen the danger or change the luck if they are not attended to.

I append a table showing the approximate striking force of the bullets of the rifles treated of.

·500	Express	hollow	bullet	... 29	Striking force in 100s ft. lbs. without reference to penetration.
„	„	solid	„	... 32	
·577	„	hollow	„	... 34	
„	„	solid	„	... 37	
·303	„	„	„	... 19	

O. C.

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VI.—EXTRACTS, NOTES AND QUERIES.

The Timber Trade of Siam.

According to the customs returns, the export of teak was 49,690 tons, value 264,805*l*., as compared with 48,994 tons, value 296,107*l*, in 1895.

The quality in the returns is stated in piculs, and it appear that the customs authorities consider a picul weight ($133\frac{1}{3}$ lbs.) of teak as equal to $\frac{1}{20}$th of a ton in measurement, and piculs have therefore been converted into tons on this basis.

The following is a short summary of the returns :—

ANALYSIS of Exports of Teak from Bangkok in 1896.

Destination.	Quantity.	Value.
	Tons.	£
Europe	$6,075\frac{1}{2}$	57,005
Bombay	$13,502\frac{1}{2}$	61,882
Hong-Kong	9,046	48.691
Singapore	11,204	24,528
Saigon	$340\frac{1}{2}$	2,660
China	$1,030\frac{1}{2}$	3,000
Coast	287	1,301
Other countries	8,204	65,738
Total ...	49,690	264,805

Other information which I have received from private and reliable sources gives the same total export in tons, but some mistake appears to have been made by the customs in the figures for the different destinations, the quantity exported to Europe being probably nearer 18,000 tons and to Singapore not more than 3,500 tons.

The returns show very great variations in the average value per ton of teak exported to the various ports, the Singapore valuation (21 dol. 89 c.=2*l.* 3*s.* 9*d.*) being the lowest, and that for shipments to Europe the highest, viz. : 93 dol. 82 c. (9*l.* 7*s.* 7*d.*)

The year 1896 witnessed a steady rise in the value of teak, not only in the home markets, but also, though to a lesser extent, in the Asiatic ports, and the average f.o b. value of teak may be put down at 90 dol. (9*l.*) per ton for the quality shipped to Europe and 40 dol. (4*l.*) for that shipped elsewhere.

On this basis and assuming all the timber shipped to Europe to have been of the higher quality, and that shipped elsewhere to have been second class, the total value of the exports from Bangkok may be taken as 288.760*l.* The export in 1895 was valued by the customs at 296,107*l.*, but by local timber merchants at 214,717*l.*, and it may be safely assumed that the export in 1896 considerably exceeded that of 1895 in value, although the quantity was put down in last year's report at 61,828 tons.

The total number of logs which arrived at Chainat, the duty-station, about 100 miles above Bangkok, is reported as 58,606, being about 12,000 logs below the average of the four preceding years. At one time it appeared probable that the season would turn out a comparative failure, but late rains up country brought down some thousands of logs which had not been expected, and the abnormally high prices ruling in Bangkok induced traders to bring down timber which would otherwise have been left till next season.

Logs arriving at Chainat were sent on to Bangkok with as little delay as possible, and the number of logs recorded as despatched from the duty-station is 59,522, or about 900 in excess of the numbers received during the season.

The number of logs reported as having reached Bangkok is 51,547, being about 8,000 short of the number reported to have been despatched from Chainat. It is therefore evident that a number of rafts must reach Bangkok without attracting general attention, and it is supposed that some of them at least get mixed up with the small logs used for local consumption, of which about 20 000 to 30,000 logs come down annually, and which are mostly used for building purposes.

There are now five large steam saw-mills in Bangkok, of which three are British, one Danish, and one Chinese. The Siamese Government have started a small mill for their own use just above Bangkok; the owners of the present Chinese mill have a new one in course of erection, which promises to be the largest in Bangkok when completed, and another British firm who have lately established a branch here are contemplating the erection of a new mill.

Besides the steam saw-mills above-mentioned there are about 60 saw-sheds in which teak logs are sawn up by hand.

Last year's report stated that Siamese teak is becoming recognised abroad as being the same desirable article as Burma teak. In this connection it may be useful to note that Messrs. Denny, Mott and Dickson's wood market report for May says:—"It is increasingly admitted that first-class Bangkok wood is far more economical in conversion than the inferior Burma wood, which increased values have brought forward during the last few months, and so long as Siamese shippers continue to maintain their standard of quality their shipments will continue to find a ready market at the expense of the Burmese shippers, who are trusting to the good demand for teak to enable them to lower a standard of quality which has been none too high during recent years."

Again, their report for June says:—"Bangkok cargoes continue to maintain their good character, both for careful shipment and conversion, which more than compensates for the, perhaps, less kindly nature of the wood, as compared with that grown in Burma."—(*Consular Report.*)

Report on the Cultivation of Olives in Italy.

Origin of the Olive.

It is certain that the greater part of the Mediterranean littoral was in ancient times, as it now is, the home of the olive, and of all the countries which claim the tree as indigenous, Italy is that which is the chief of the oil-producing countries of the region. And in Italy it grows upon a great variety of soil, and in a fair variety of climate. It is found wild on the scorching and rocky hills near Taranto where it grows from seeds which have probably been carried from place to place by birds, and casually deposited in some fissure where sufficient soil has been found to nourish the young plant. For birds are extremely partial to olives ; indeed in the southern provinces of Italy, where the large migratory thrush, so heartily praised by Horace on his journey to Brundusium, still abounds, we find the expense of gunpowder for bird-scaring a considerable item in the olive grower's accounts. The cultivated olive, too, is a tree which is very independent of soil and may be seen growing on a rocky hillside or on the deep soil, of the plains and flourishing as well in the one situation as in the other.

Oils of Lucca and Bari.

The small provnice of Lucca has given its name to the finest table oil in the world and though the best oils of Bari in this district compare favourably with it, they have not the same celebrity. In point of quantity at least, this consular district is far ahead of the rest of Italy, as will be seen by the following figures.

Production and export.

The total amount of olive-ground in Italy is officially estimated at 908,072 hectares (a hectare being roughly 2½ acres); of which 492,430 hectares, or more than half the total, are in this district. The total produce of oil is reckoned at 3,350,143 hecto litres, of which this district yields 1,934,948 or more than half of the produce of the whole kingdom. Of the South Italian oils, those of Bari have the greatest repute, and many of the trees are of very great antiquity. The annual export of oil from Italy amounted in 18·8 to 63,500 tons. A very large proportion of this export goes to the British Empire, and though no doubt the importers care little about the methods of the cultivation of the tree, as compared with the market price at which they can purchase the oil wholesale, the cultivation is an important item to British trade, because a determined effort is being made to introduce the tree both into South Africa and the Australian Colonies. The plants are being sent out in considerable numbers from Naples, chiefly, if not solely, by the firm of Messrs. Dammann, of Portici, a suburb of Naples, who have also charged themselves with the introduction of the Karob into South Africa.

Uses of oil.

It is unnecessary to mention the variety of uses to which olive oil is put, but it may be interesting to note that large quantities are used on sheep-runs in the Colonies for sharpening the clippers at shearing time. Time also can show what success the introduction of the tree will have in our Colonies. It may be that the best oil will be produced ; it may also be that only the lower class oils, such as those grown in Turkey, which are only useful for making soap, will be manufactured, but at any rate a useful lubricant will be obtained, and a very picturesque tree added to the landscape. In the meantime a report in English on the cultivation of the plant cannot fail to be of service.

The oleaster. Olive wood.

The wild olive or oleaster is a tree of small stunted growth and yields a fruit from which very little oil can be procured. The grafting of the oleaster was known in very ancient times, and is mentioned by St. Paul in his Epistle to the Romans who, however, for the reasons of his metaphor or perhaps from ignorance of arboriculture, reverses the process, and describes the oleaster as being grafted on the olive, whereas of course it is the cultivated tree which is grafted on the stem of the wild one. The oleaster can be raised from seed in the ordinary way, or it can be raised from the fungoids which olives bear underground at the point where the roots separate themselves from the trunk. Olive trees live to a very great age, and their wood is very useful for cabinet making, as it is hard as well as pliable and can be easily manipulated. The smaller boughs form excellent fuel, for owing to the oil in them they burn like a torch, and as the trunks of old trees are apt to become hollow, many of them are only fit for the same purpose. The tree is evergreen, and the leaves fall after about three years, being of course constantly replaced in the course of nature by younger ones. The olive commences to flower at the base of its foliage, the flowers gradually extending upwards. The best crops are always obtained when the trees flower early, and this occurs (when the spring is mild) as early as the month of March but the tree is susceptible to cold, and if it gets checked it will flower as late as June, in which case a failure of the crop may be anticipated. Old trees usually yield a crop only in every alternate year, which is gathered in the autumn and early winter. The largest trees are found in Sicily, where they grow almost like oaks, and may be found measuring 25 feet round the trunk.

Varieties.

The Italian Blue Book on Agriculture published in 1874, names 300 varieties of tree as existing in Italy, of which 67 are found in this Consular district. Obviously, in a country like Italy

where so many dialects are spoken, in many cases the names of these varieties are purely local, and as the same variety is called by one name in Tuscany and by another at Naples, it would be absolutely useless to mention distinctions which have no difference, in a report written for British readers.

Classes of olive.

Olives are in fact divided into three classes, namely :—(I) the small olive with few leaves, which grows freely, resists the cold better than the others, is more free from disease, grows on the poorest soil, and though generally very hardy, does not yield oil and is useless for table purposes. This tree will oil yield good enough for sharpening shears and for mechanical purposes generally, and it will grow almost anywhere. It is known by the names of "Miguda," "Trillo," "Cerisiola," and "Martino," in Italy. The second class known as "Olivi di Spagna" has larger leaves, a large and succulent fruit adapted for table use, subject to the necessary treatment. These trees require rich and good soil and no great vicissitudes of temperature ; they will not bear cold, and are subject to a good many diseases. If they get chilled the fruit falls, and such berries as remain give but little oil, and that of poor quality. These varieties are supposed to have come to Italy from Spain, and to have found a climate in Italy which does not always agree with them. They might all the same do well in the warmer climate of Australia. The third class is preferable for general cultivation, as it avoids both extremes, being hardy, and at the same time producing a good and useful crop. These are known in Italy by the names of "Razze," Corniola," Ogliarolo," "Pigudo," and "Monopolese."

Climatic conditions.

Like the palm, the olive will flourish in many places where it will bear no fruit. It will not yield in very hot places, and it will not endure frost, or sudden transitions from cold to heat ; it does not mind sea air, and in many places on the Mediterranean it grows to the water's edge, where it must often be affected by salt and spray. Twelve degrees centigrade below zero (10·4° Fahr.) is enough to wither the leaves and to kill such roots as are on the surface. A late spring frost is naturally more harmful than a winter one, and damp cold than dry, conditions which apply to all evergreen trees. In this district the altitude at which olive trees can be found may be reckoned at 1,500 feet above the sea-level. As a rule they thrive better on hills than in the plains, because any cold they are subjected to is less damp in the former situation than in the latter. In a temperate season the trees in the plains will bear better than those on the hills. With regard to exposures: in this climate the east and north are preferable as affording less sudden changes than the southern and western exposures, but

south of the "line" the conditions would be different or perhaps reversed; the main point to be considered being to give the trees as equable a temperature as possible, and to avoid frost and violent autumn winds which are apt to shake down the berries.

Manure.

Olive trees are the better for manure, but the kind of manure used depends, as will be seen, very much upon the nature of the soil in which the tree is planted. Farmyard manure, if well decomposed, may be placed in trenches round the trees, but special care must be taken to put such trenches far enough away from the trees so that the roots are not mutilated by the digging, as they are particularly susceptible to injury from this cause. It is a good plan to soak the husks and refuse of the oil presses in water till they have thoroughly rotted, and then infuse manure and other decaying vegetable matter in the water before placing it in the trenches. Too much manure should not be given at one time, little and often being the golden rule. Of artificial manures, soda is that most frequently used. Lime and silica are necessaries, but care must be taken in applying them that they are not already existent in the soil in sufficient quantities, as if they are abundantly present, more harm than good will be done by their application. Wood ashes and phosphates may safely be mixed with the manures used. The autumn is the best season for the application, as the manures get incorporated into the soil during the winter, and serve to feed the roots more plentifully in the spring. Most trees are the better for being manured annually. Green crops for sheep feeding or cabbage can be grown between the trees without injuring them.

Dead trees, shoots from. Seedlings.

It will be many years before any olive tree in the colonies falls from age, or, being mature dies a natural death. When a tree dies it can be sawn off above ground, and, if the roots are still alive, they will throw out offsets. If these are attended to, and the bottoms of them well covered with earth, they will throw out rootlets, and, when these are well grown the shoot can be cut off with its roots and put into the nursery. One or two good shoots should also be left on the old trunk, as they will throw up and form useful trees. They will require grafting in due time. Where the wild olive tree grows, it is a simple matter to transplant it and graft it, but this will not occur in the colonies for many years to come. The olive will also grow from seed and this, in fact, though it is a slow process, is in the end superior to any other. The trees do better, live longer and are much less liable to disease than those propagated in any other way. The seed will germinate in the second year if left to itself, but, if it is softened by being placed in a pap of clay and cow-dung, and sown

thus, it will germinate the same year. It is necessary to sow in thoroughly clean ground so as to allow a free and prompt expansion of the rootlets. The ground should be dug three feet deep, thoroughly cleaned and richly manured. This should be done in the winter, and in the spring the surface should be laid out in shallow trenches, in which the seeds should be sown in rows about a foot apart, with a distance between the seeds of not less than six inches. The sharp end of the seeds should be upwards, and they should be treated with a fair amount of water. It is especially essential that the ground should be kept clean, and all weeds immediately removed. In the spring of the third year the seedlings may be moved to the nursery, all shoots appearing on the tiny trunks having been carefully removed.

Propagation by fungi.

The most usual way of propagating the olive is by means of an egg-shaped fungus growth,* which is found upon its roots. It is about the size and much the shape of a turkey's egg, and grows outside the bark. Not more than two of such fungi should be removed from a single tree, or damage will be done to it. Indeed, if propagation is attempted on a large scale, it is better to sacrifice one tree altogether than to run the risk of injuring a greater number. Thus a hundred or more of these fungi can be obtained from a single tree in the winter, besides a great number of slips and grafts in the spring when the tree can be felled and disposed of. The removal of the fungus must be done with care. The wood of the root round it must be carefully sawn or chipped with a sharp axe. A chisel must then be used to undercut the fungus, and finally lift it out of its place. The wood which adheres to it can then be cut off with a sharp knife. If the fungus has plenty of eyes it may be cut up like a seed potato, but it is always advisable to make the pieces so large that each piece should have three or four "eyes." If the fungus has made any roots these should be carefully removed. The best time to take them is in the winter, before the sap begins to rise, and they can be kept till the spring in dry earth, mixed with chaff to soften it. They should be planted in March.

Propagation by cutting.

The only remaining method of propagation is by cuttings. These should be about 18 inches long of which 12 inches should be beneath the surface. The thickest or lower end of the cutting should be cut into the shape of a wedge, be well daubed with cow-dung and covered with garden mould. It can then be planted, care being taken in making the holes not to twist the rod which makes the hole, otherwise the sides of the holes become hard, and the rootlets do not get a sufficient chance of expansion,. Cuttings with boughs to them are treated in the same way, save that the

* We wonder if this is a *real* fungus, or if it is not rather of the nature of a tuber. Hon. Ed.

cutting is laid in the ground horizontally, but with the thick end lower than the other and the boughs allowed to protrude above the surface. In a year's time the part beneath the surface will be furnished with roots and the boughs with leaves. The whole thing can be taken up each bough separated from the other and the cuttings placed in the nursery.

Grafting.

The oleaster is grafted in the same way as other fruit trees namely either by sawing it off and inserting two or three grafts between the bark and the trees; or by cutting a slit with a transverse cut in the shape of a T, opening up the bark and inserting the graft, or again by cutting away the bark and a portion of the wood from the bough and the graft, making a point of contact of about half an inch, and then binding them strongly together with wool and covering the point with a mixture so as to seal it hermetically. All shoots which occur below the graft should be cut off.

The following is a useful mixture for the purpose of grafting:—

			Per Cent,
Black Swedish pine	..	...	28
Burgundy pitch	...	...	28
Yellow wax	...	...	16
Lard or tallow	...	...	14
Ashes	...	...	14
Total	...	...	100

Nursery.

Much need not be said about the nursery, as this part of the subject is influenced by local conditions which are known on the spot and may perhaps differ materially from conditions prevailing in Europe. It will be useful to mention that the ground in the nursery should not be too rich, because, if it is, the young plants form far fewer roots to feed themselves with than will maintain them in poorer soil, and hence they get a serious check when they are moved to their permanent home where the soil will naturally be poorer than that of the nursery. If, on the other hand, they have been grown in comparatively poor soil they will have made more roots, and will move much better. In whatever way the trees are propagated they should remain eight years in the nursery before going to their permanent home. In the case of

plants grown from the egg-like fungus a certain amount of careful cultivation is necessary. About six weeks after they are planted, shoots like asparagus heads will appear In order to give these every chance the ground above them must be kept loose, and if it has become dry and caked it must be watered. From each piece planted some half dozen shoots will rise. Of these only the vigorous straight ones should be preserved, the rest should be carefully pinched off below the surface with the finger and thumb, care being taken not to move the plant which by this time will have made tender rootlets.

Pruning

Not more than two shoots should be left, and these should be trained to sticks. Later on the less vigorous of these should also be removed. *The training of all shoots, whether from cuttings,* fungus, or any other means of propagation is most necessary. At first, they can be trained to canes or small sticks, but when they begin to make a top it will be necessary to support them with a stout stick and to continue this support till thed have thoroughly taken root in their ultimate home. On hot dry soils, such as will generally prevail in Australia, it is desirable to keep the trunks short. Hence in grafting they should be sawn off from three to four feet above the ground level. In fertile soils in Italy, the height is left at as much as five feet, but in arid soils the rule is "the shorter the better." The fewer boughs left on the stem the better. Some growers cut them all off, but the effect of this is to delay the fruiting of the tree by a year or so. Whether it answers in the long run is a point much disputed, and not very easily capable of proof.

Planting.

Olive trees should be planted not less than 20 feet apart in ordinary soil, but where the soil is good this will not be *sufficient, and 40 feet is a safer distance. The holes should* be three feet deep, and three feet over, and where the soil allows of it they should be dug two or three months before they are wanted, as exposure to the sun and air is found to fertilise the soil taken out of the holes. It is desirable to put stones, or dry rubbish in the bottom of the holes for drainage, and if the land is damp it will be necessary to drain it, consequently ground with a good fall should always be selected. The best manure consists of the scrapings and fragments of horny substances and ground bones. Deep planting is not recommended, and the trees should be set about six inches deeper than they were in the nursery. The shoots should be pruned in order to stimulate the roots, and a trench or cup left round the tree to collect rainwater.

If the following season should be a dry one, it will be necessary to water the plants copiously. All shoots that appear on the trunks should be taken off at once, unless they are so situated as to eventually form part of the top of the tree. The best way to take them off is to rub the tree down with a piece of canvas. This not only removes the tender shoots, but prevents the trunks from accumulating lichens and mosses. All plants do not sprout in their first year, it is therefore important to make sure that any plant is dead before taking it up. For three or four years the plants should be left quite alone, after which the weaker boughs should be cut away, care being taken that those which are left are as symmetrical as possible to insure a handsome top to the tree. Boughs can, of course, be pruned and trained into their places if necessary. It is better also to remove roots which are too near the surface, as they prevent the development of the lower roots which are essential to the tree. In the fifth year pruning should be carried out. The dead knob above the grafts should be carefully sawn off obliquely with a sharp saw, and the place covered over with the pitch composition given above to prevent the tree from bleeding. The top should then be carefully pruned so as to secure a shapely tree.

Props.

As the tops will now be getting heavy the trees require more support to save them from the wind which otherwise would displace the roots. Three props should be put to the trunk of each tree, and at the point of contact the tree should be protected by a band of straw, so that the props may not chafe the trunk. It is also necessary, when winter comes on, to bank up the trees by making a trench round the roots, and throwing the earth up against the stem. This must be levelled again in the spring, leaving a circular trench on the upper side of the tree to collect any rain that may fall.

Picking.

From this time onward the pruning of the trees becomes very important, and should be attended to every year as soon as the crop is gathered. It must be remembered that the vertical shoots of an olive do not bear fruit, and that no shoot bears fruit in its first year, so that care must be taken to distinguish between the second year shoots and those of of the first year. Unless the trees are properly pruned the fruit will be small, will give very little oil, and will only yield every other year, whereas with proper pruning the trees may be made to yield every season. The fruit should be hand-picked, or allowed to fall from the tree on to a canvas or sacking

spread beneath it. The boughs may then be shaken but the tree should on no account be beaten, as this knocks it about and injures the shoots, which will, if left unharmed, bear fruit in the following season. The egg-shaped fungus which we have already mentioned as appearing on the roots of mature trees should all be carefully cut off as soon as they appear, as they take too much out of a growing tree. Local experience alone can decide the best methods for a particular locality, but it may be accepted as a principle that vertical shoots may be taken off, all dead wood removed, and branches which have borne much in the preceding year cut back to allow more nutriment to pass to the others. Too many buds should not be allowed on any branches.

Enemies of the olive.

Dacus oleæ.

Like other fruit trees, the olive has many enemies, Besides the birds we have mentioned, who occasionally atone for their thefts by producing what we are pleased to call "self-sown oleasters," there are numerous insects which attack the fruit, the wood, and the leaves. The most dreaded of these is a small fly called the "Dacus oleæ," which is about half the size of a common house fly. It has a yellow head and green eyes, and an ashy-grey back with gossamer wings. The female has a spur like a wasp with which she punctures the fruit and deposits an egg in the lesion. It is calculated that a single fly will thus destroy three or four hundred olives. These eggs develop into larvæ, which completely tunnel the olive, leaving nothing but the outer shell and the stone. In about a fortnight they assume the chrysalis stage, and about 10 days after that the perfect fly issues. This it will be seen displays an alarming fecundity combined with an extraordinary rapidity of reproduction, and in favourable seasons terrible damage is done. The only known remedy is to gather the fruit early, and by crushing it at once to destroy the larvæ.

Coccus oleæ.

The "Coccus oleæ" is the enemy of the boughs and leaves. It is a parasite which at first sight appears to be a portion of the branch upon which it grows, and upon the sap of which it lives. It also develops a fungus which blackens the boughs. Lime washing and petroleum have both been tried with some measure of success against this pest.

Some growers burn damp straw under the trees in order to fumigate them and destroy insect life, but this must be done with great caution, as the olive is a tree from its

nature very easily scorched, and very much damaged by *scorching both in fruit and foliage. It is* not desirable to allow lichen or moss to grow on the bark as it offords a refuge for parasites, and a home for the eggs of insects.

It is, however, reasonable to express the hope that the olive tree when introduced to its new home in the Antipodes will leave all these enemies behind it, and not find new ones to contend with, so that is may grow and prosper till it has bestowed wealth on the Australian continent in the same abundant measure as it has lavished it on the Italian Peninsula for so many centuries.—(*Report of E. Neville-Rolfe, H. B. M's Consul at Naples.*)

Tapping of Indiarubber trees in the Charduar Plantation, Assam.

In reviewing the Assam Forest Report for 1896-97 last month we suggested that it was about "time to begin tapping trees 'which reach 19 ft. in girth and an average height of 77 ft." Since then we have come across the Report of the Imperial Institute for 1896-97, in which we see a letter from the Deputy-Conservator of Forests, Darrang Division, in which he estimates that at each tapping a tree might be expected to yield 4 chittacks. He estimates 12512 trees available, and that these might be tapped once in 5 years, or 2502 trees annually. This would give 15½ *maunds per annum, valued at Rs. 105 per maund.* Thus, the revenue would be Rs. 162,718 yearly, though as the trees got older and bigger this would propably increase. It certainly looks as if it would be worth while to begin.

The Metallization of Wood.

The following process, invented by Mr. Rubennick, for metallizing wood, is thus described by *Les Mondes* :—The wood is first immersed for three or four days, according to its permeability, in a caustic alkaline lye (calcareous soda) at a temperature of from 75 *degrees to* 90 degrees. From thence it passes immediately into a bath of hydrosulphite of calcium, to which is added, after 24 or 36 hours, a concentrated solution of sulphur in caustic potash. The duration of this bath is about 48 hours and its temperature is from 35 degrees to 50 degrees. Finally, the wood is immersed for 30 to 50 hours in a hot solution (30° to 50°C) of acetate of lead. The process, as may be seen, is a long one, but the results *are surprising. The wood thus prepared after having under-*

gone a proper drying at a moderate temperature, acquires, under a burnisher of hard wood, a polished surface, and assumes a very brilliant metallic lustre. This lustre is still further increased if the surface of the wood be first rubbed with a piece of lead, tin, or zinc, and be afterwards polished with a glass or porcelain burnisher. The wood thus assumes the appearance of a true metallic mirror, and is very solid and resistant.—(*Timber Trades Journal.*)

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Some Remarks on the Moharbhanj Working Plan Report.

When reading the review on the Moharbhanj Working Plan Report in the June "Forester," I noticed that a rule had been devised for regulating in practice the density of overhead cover in a Sâl forest. The phrase runs :—" The crowns of seed-bearers are 'to be kept dense enough to touch when swayed by the wind, 'until such time as a young crop is obtained." I concluded that the Working Plan Officer intended, not as here set forth, to operate on the crowns but to keep the stems of the seed bearers so close that their crowns might in given circumstances touch, and I considered the subject from that point of view.

In a seedling Sâl forest with any claim to vigour, the minimum girth of a seed-bearer should not be under 4 ft. and stems of this size with developed crowns, implying long freedom from lateral pressure, should be so infrequent as to be left out of consideration. The higher girth classes again are not much affected by wind; the habit of the Sâl is opposed to swaying; it withstands in its rigidity or breaks, but does not bend. It would appear, then, that the rule would not serve in practice, a Sâl seed-bearer in the *majority of cases should not sway, and even if it did, the definition* simply implies that stems of from 4 ft. to 8 ft. girth should be retained in sufficient numbers so that their crowns remain in close proximity until a young crop is obtained.

But such a prescription even, vague as it is, is open to objection. It infers that throughout the Sâl forests of Moharbhanj, it is in contemplation to produce by artificial means a more or less equally diffused shade of varying intensity, and to maintain it until a young crop is obtained. The creation of this ideal canopy by favoring the growing stock is easy, but until the Forester of Moharbhanj breaks through it, allowing the establishment of groups of advance growth over small but distinct areas, he will not be satisfied with the result. He may, indeed, obtain a crop of young seedlings in spite of the uniform canopy, but these will bide their time until accidental interruptions of the overhead cover

permit a forward growth. I too, once dreamt of healthy advance growth of Sâl standing in well-represented age classes under the even shade of the parent stems; I woke to find that the community is composed of family groups, each in itself complete; and that the removal of the head of the house by axe or natural decay, was the signal for self assertion in the offspring, followed by a lengthy struggle in the hope of filling the vacant post.

Mechanical regulations to be useful must be more definite than this; and they are even then inapplicable in a forest where the circumstances of each family group have to be considered, and where, within the area of a few acres, all those varied operations which in combination form one general system of management may, for the benefit of the forest, be in progress at one time. The possibility of the forest will indeed be limited by the condition of the canopy; but it will not be increased, as the reviewer leads us to infer is the opinion of the Working Plan Officer, by maintaining the overhead cover more or less complete over the whole area.

Sleepers on the North-Western Railway.

We give below an extract from a paper in the "Indian and Eastern Engineer" for June by Mr. V. E. DeBroë, M. I. C. E., which gives an account of the laying of the permanent-way on the North-Western Railway and of the sleepers used, which we are sure will be read with interest by many officers of the Department, and especially by such of them as are employed in the working of the forests of the Punjab and North-Western Provinces, Kashmir and other Native States. Such Officers will readily notice the various inaccuracies and will smile at the naive advice to Government and the Rulers of the Native States to "kill the goose." With the exception perhaps of those of some small States, we believe we are right in saying that the whole of the deodar forests are under "Working Plans" or at any rate "Plans of Operation" devised to ensure that no more is cut than is warranted by the estimated permanent Annual Yield. We wonder where the writer got the notion that the deodar forests were 'practically inexhaustible' and many of us would like to know where are the 'virgin forests to the rear' which 'stand totally unexploited'? Mr. McDonell might perhaps tell us if any exist in Kashmir. If they do, their presence has probably been fully taken account of in the calculation of the Annual Yield. What a lovely mess the proposed Company would make of the deodar forests, and what a fine profit they would put into their own pockets, with the "Managing Director at Lahore" the "Government concession," and the "guarantee of custom from the State Railways;"

and how they would rejoice to have cleared out everything and left the Railways and other users of deodar timber, the joy of waiting another fifty years or so till the next crop came! And as regards the "successful exploitation of teak," probably Mr. Ribbentrop and the Burma Conservators could tell us some interesting stories of the other side of the question. Luckily, of course, there is very little chance of Government or Rulers like the Maharaja of Kashmir being taken in by transparent advice of this kind. With these remarks, we leave our reader to study Mr. De Broë's paper.

Permanent-way.—On the road being taken over from the Company, a careful survey of the permanent-way was made. Save on the first few miles out of Karachi, over which a double-headed steel rail, weighing 68lbs., had replaced the *old iron road, the 65lb. iron rail, described by Mr. Brunton* on page 15, was still carrying the traffic, and but for the fact that a heavier class of engine was introduced by Government, would have probably served for some years to come, with a moderate programme of annual renewals. The iron was of excellent quality, and the best of the rails are still in use on sidings devoid of through-running. The 68lb. steel rail, though somewhat light, has been retained in the interests of economy, but the whole of the remainder of the road to Kotri has been relaid with a 75lb. steel flat-footed rail. A long six-holed steel fish-plate was introduced which, however, proved of doubtful efficiency as compared with the four-holed type, as its length prevented the joint sleepers being placed sufficiently close together, and the full number of bolts held the two contiguous rails so firmly as to arrest natural expansion, thus causing the road to buckle. Eventually, two of the four fish-bolts were removed. A later and much superior type of fish-plate, four-holed and of angular section, was used on the new down-line. The 75lb. rails are of 30 feet length.

As regards sleepers, probably the whole of those laid in Mr. Brunton's time had disappeared. Certainly no English pickled Pine remained, and with the exception of a few miles at the Karachi end, laid with Denham and Olpherts' iron sleepers, the whole road was laid with deodar. Under the 68lb. steel rail these were comparatively new, but the rest were on their last legs. The whole road, therefore, underwent sleeper renewals. Facilities for obtaining deodar sleepers, which are undoubtedly the best for the Indian climate, are, of course, far greater than 30 years ago, but the demand has increased enormously and the supply falls far short of it. A few miles were spared from the Punjab for the renewals in question, but the greater part of the road was relaid with the pea-pod steel transverse sleeper. A few miles were also laid experimentally with teak from Singapore, and a few

miles with a class of timber claimed by the providers to be Burmah pingado, but which, on being subjected to examination by a botanical expert attached to the Forest Department, was pronounced to be an inferior description of jungle wood. Ten sleepers per 30 feet rail were at first used, but it was found a better road, less liable to creep, was obtained by using eleven sleepers. The rails were spiked down in the ordinary way, double spikes being used at the joints. Bearing-plates were used on each sleeper on open bridges and at all joint sleepers in the road.

The new down-line was laid partly with a $77\frac{1}{2}$lb. bull-headed rail, seated in heavy chairs fastened to the timber sleepers by four round spikes and keyed with wooden (Babul) keys, and the greater portion with the 75lb. flat-footed rail. Many miles of real Burmah pingado sleepers were imported for *this job.* Some *miles* were *laid* with deodar, and quite half of the distance, or over 50 miles, consisted of what are classed as "Indian Midland Pots," a cast-iron bowl sleeper giving a long bearing to the flat-footed rail, the flange of which is keyed to the pot with a steel key. The fishing on the new line is with the four-holed steel angular plate.

Of the various descriptions of the permanent-way in use on the North-Western Railway (and they include many varieties besides those above-mentioned), unquestionably the best class of road, for a heavy traffic, is a double-headed rail weighing not less than 75lbs. per yard, heavy four-holed chairs, deodar sleepers—eleven or even twelve (on curves) to the 30ft. rail—and the angular four-holed fish-plate. The flat-footed rail on timber sleepers cuts through them in time, even with a liberal use of bearing-plates, and the spikes draw when once the timber begins to decay. This class of rail, both when on timber and bowl sleepers, creeps badly, which causes joints to lap and a difficulty in keeping the gauge true. The Denham and Olpherts' road is too weak in the tie-bar, which buckles, causing a displacement in the gauge, and the wheel flanges invariably, after a time, are found to ride on the jaws of the casting, into which the rail fits. The Singapore teak sleepers and the so-called pingado put into the up-line proved worthless, being quite unfitted to the climate. The timber suffered from dry rot, and split badly in the sun. The steel pea-pod sleeper is useless where exposed to the slightest damp in the soil or to the action set up by saltpetre; in these circumstances, it perishes rapidly from corrosion, giving way, to begin with, under the rail seat. Even when laid in the driest of situations, where oxidation does not take place, there are objections to it. The platelayer complains that he can never keep this class of road to gauge. Owing to the elasticity of the metal

or inequality in distance apart of the lugs or difference in thickness of the keys, it is certainly most difficult to maintain two contiguous rail lengths to precisely one and the same gauge. Fast trains, moreover, throw the road out of straight, and when the platelayer sets to work to slew the road back into line, he finds *the spring in the permanent-way throws the next pair of rails out.* Another objection is that the joint sleepers fall too far apart, and the attempt to place them nearer is met by the impossibility of driving the joint keys unless they are cut. Of the real pingado sleepers, it may be said, that they are good. They split to a certain extent, but the timber is hard and heavy and the splits do not destroy the tenacity of the fibre, as in the case, for instance, of the Singapore teak. But the pingado is most expensive. Those laid cost Rs. 6-12 landed at Kimari, whereas a deodar sleeper can be obtained for Rs. 3-8 *including rail carriage from the Punjab. As regards the "Indian* Midland Pots," it is doubtless a vast improvement on the old cast-iron pot, but it does not support the web of the rail laterally, the fastenings being in contact with the flange only, and it is a question whether the tie-bars will not be found to buckle as they do on all pot roads hitherto designed. Creosoted pine from England or Norway are expensive, and their defects, as pointed out by Mr. Brunton on page 16, are as apparent in the present day as they were when he wrote. Babul wood and the other indigenous timbers mentioned by the author are worthless, as they do not *stand the climate*, and the Burnettising, and other chemical processes mentioned, have long since been abandoned.

Deodar is the best material for the whole of the north-west of India's dry climate. It is cheap; white ants do not attack it seriously; it does not suffer under derailments to the same extent as cast-iron; it is light and, therefore, portable; it can be floated down the five great rivers of the Punjab at a nominal cost for carriage; it is of use for crib work on flood breaches where cast-iron is useless, and it has a life of quite 20 years, or even 25, if fairly treated by the maintenance engineer.

Now the provision of sleepers for renewals alone, quite apart from railway extension, is, considering the enormous mileage now open, becoming a burning question. By multiplying this mileage by 2,000 sleepers (to include sidings and double portions) and dividing by a life of 20 years, we arrive at an enormous figure representing the annual requirements for the upkeep of our lines, and applying the simple formula to the whole of the North-Western and the Rajputana-Malwa Systems, as well as to a portion of the East Indian and the Oudh and Rohilkand Railways, we learn how immense to Government the advantage would be of further developing the trade in deodar timber. The existing arrangements for supply are based on no preconceived plan, and are partly in the hands of private merchants, and partly of the Forest

Department. The deodar forests are said to be inexhaustible, but the zone of felling operations is limited by want of communication. Such portions of the forests as are close to the river come under the axe, while virgin forests to the rear stand totally unexploited. The native timber merchants now in the field have neither the capital nor the enterprise to launch out on a bolder scale of operations, and the Forest Department, with a small staff of officers, regards the sale of timber as but a concomitant to its more legitimate business of promoting the growth of trees. A strong Company, based on sterling capital, and backed with a Government concession and a guarantee from the State Railways of the continuance of their custom over a period of years, would find ample scope for their operations. Roads, portable railways, here and there a funicular railway, steam saw-mills, etc., would have to be pushed into the interior, and a staff of European agents thoroughly conversant with the natives and having a technical knowledge of the characteristics of a good sleeper, would be required ; the whole to be entrusted to a Managing Director with head-quarters at Lahore, who would be in touch with the managers of the various railways. The teak forests of Burmah have been successfully exploited somewhat after this fashion, and there seems to be no reason why the Himalayan pine should not be dealt with in the same manner. Failing private enterprise, it would pay Government in the Public Works Department to establish a special branch to insure a constant flow of sleepers to their railways, and possibly it would be better worked by the State than a Company, because large forest areas lie in Native States, and political questions would arise. The price of deodar in log, delivered by flotation down the rivers, is now about 12 annas per cubic foot, and with methodical arrangements as above outlined, this would no doubt, fall appreciably, and the supply of cast-iron sleepers from Europe would find the keenest of competition in the indigenous material.

In dealing with the cost of the permanent-way in the present day, as compared with 30 years ago, we meet with a difficulty, as Mr. Brunton makes no mention of price of rails and fastenings, and there appear to be no records on hand; but the cost of the metals is unimportant, because any difference would be attributable to the fluctuations in the home metal marts. The Company's sleepers cost them, as stated by the author on page 16, from 6*s* to 8*s* 11*d*. each, or say Rs. 3 to Rs. 4½, which is cheaper than now, a deodar costing not less than Rs. 3½, a pingado quite Rs. 7, and an Indian Midland Pot about Rs 8. The original expenditure on plate-laying, however, appears to have been very high. Six shillings a lineal yard, £528 to a mile, amounting to the enormous sum of £57,000 for linking in 108 miles of line, is somewhat startling. To this sum, moreover, has to be added inland freight on 5,500 tons (or about half the total quantity of rails), amounting to 2*s* 6*d*. per ton, or nearly £6,000, so that the plate-laying, including

carriage, amounted to nearly £63,000. Omitting the latter item, which is not comparable with the cheap railway freight of the present time, the work which cost 6*s*. per lineal yard, would now be estimated at not more than Re. 1 per lineal yard, equal to 2*s*. of those days or one-third the rate, and this would be a liberal estimate. The rail renewals on the Karachi district, including pick-up trains for the condemned material, cost Rs. 1,000 per mile, or 9 annas per yard, and the plate-laying on the doubling (where carriage of material was simpler, owing to having the adjacent line, than it would be on construction plate-laying carried out telescopically), was done at an initial cost of 4 annas per yard, which totalled up to 8 annas when train charges, tools, boxing, packing and maintaining the road in a fit condition for construction trains for several months was included. This is one-sixth of the cost of the plate-laying on the Scinde Railway. The figures do not appear even to include plate-laying on sidings, for the number of yards, quoted by Mr. Brunton on page 10, represent 110 miles only, rather less than the length of the main line, which is quoted as 108 miles 10 chains + 3 miles 15 chains double-line near Ghizree Junction. As labour in those days was cheaper than it is now, the only conceivable way to account for this heavy outlay on linking in, is to suppose that the work was carried out before engines and rolling-stock were available, and that the material was all conveyed to the rail-head by country carts, or, at best, by material trolleys, and that the enormous amount of labour, required for such a method, swallowed up the money, though, as the author speaks of water-trains for the staff being run on the construction, this seems hardly likely. Even assuming that the item includes laying of all points and crossings in station yards, the rate is out of all proportion. One remaining explanation, perhaps, offers itself, *viz*., that possibly a portion of the expenditure on ballast-spreading may have improperly found its way into Mr. Brunton's accounts under the heading of "leading and laying." Adverting to page 18 of this paper, some difficulty was found in reconciling the relative cost of stone-ballasting and rock-cutting, both of which Mr. Brunton averaged out about 1*s* 6*d*. per cubic yard, whereas leading and spreading would, one would suppose, place the former item at a somewhat higher figure. Be this as it may, we can only view that gentleman's report from his own figures, which go to show that plate-laying, on the construction, cost fully three to six times what it now does on the same line. Considerable allowance must, however, in justice be made for unskilled labour, with which the pioneer engineers had to deal, as compared with the trained plate-layers, who now abound. The new permanent-way on the doubling, laid complete with deodar sleepers, cost about Rs. 22,000 per mile, and with Indian Midland pots, Rs. 10,000 per mile more.

The Forester on leave.

DEAR MR. EDITOR.—The rate of production of poetry in the Indian Forester is about one piece in ten years. I am old enough to remember two. In the first, "denizen" and "venison" were made to rhyme and I have never eaten the latter without an effort since. The second was corrected by the Editor, and utterly ruined. Our faith in you is greater: you will neither permit the publication of scandalous rhymes nor assert your prerogative in such an aggravating way.

It is a matter of notoriety, I have it in writing, that if a Forest Officer is scientific he is liable to be called a something-ologist, or if he is sporting a something-shikari: no doubt if he tries to be amusing he will be classed as a blooming idiot, but once his status is assured as such, his scientific or sporting attainments will be overlooked, and will do him no great harm.

To keep up the average poetical outturn of the Forester, I enclose an effort in which truth and sentiment are touchingly blended. There is no extra charge, the usual prize remuneration will satisfy one who feels that he is utterly ignorant of the first principles of rhyme and singing, provided always you conceal his identity under the well known name of

B-R-N.

GOING.

Indian Forests! ere I start,
Let me first the truth impart.
Joy and hope have left my breast
And I'm weary for a rest:
Hear me swear before I stray,
I'll see you—further—ere I stay!

By malaria unconfined,
Wafted in each sultry wind,
By those swamps whose reedy fringe
Accents the landscape's sickly tinge,
By each solitary day,
I'll see you—further—ere I stay!

By the sport I long to taste,
But find there is no need for haste,
By all the written snubs that tell
What words can never speak so well,
By fires and heat in genial May,
I'll see you—further—ere I stay!

Indian Forests! I am gone!
You may regret this when alone,
But though I fly from your embrace
Another fool will take my place.
He too will suffer the same way,
But *I*'ll be——before *I* stay.

RETURNING.

Indian Forests! ere we meet,
My soul goes out my love to greet.
I'll sing your praises, for perchance,
Our meeting won't my love enhance
Hear me swear before I come,
I long for you, and you alone.

By the life so unconfined,
By winter mornings' bracing wind,
By the grey plains' verdant fringe
Recalling emerald's glancing tinge,
By the camp fire when work is done,
I long for you, and you alone.

By the sport I long to taste,
By gun and rod that bid me haste.
By all the jungle signs that tell,
What words can never speak so well.
By plains and "mountain forests dun,"
I long for you, and you alone.

Indian Forests! I am come,
(I'm not so sure it feels like home).
But though I wanted to delay,
I couldn't stick it on half pay.
So thus when all is said and done,
I long for you, but *not* alone.

III.—OFFICIAL PAPERS & INTELLIGENCE.

White-ants and Forest trees.

The following extract from a papper in the Agricultural Ledger on "White-ants as a pest of Agriculture," ought to be reproduced in our pages. It was written in May 1896 by the Settlement Officer of Balaghat, C. P.

In our opinion the 'Scientific Forester' was right, and that the mango saplings planted by the Agriculturist died because they were badly planted and their roots got rotten, and then of course a legitimate prey for the termites. Very likely they were torn ruthlessly out of a nursery, left with such roots as they had, exposed to the sun for an hour or two, and then planted in a water-logged pit 6 inches below the surface of the ground. Our description of the process is not exaggerated. We have seen it carried out in various parts of the country. We hope that some of our readers will discuss the subject.

"White-ants are especially fond of young mango trees. In 'some villages, repeated efforts to make a mango grove have failed 'on account of the roots of the young trees being attacked by 'white-ants. I once doubted this fact, and was disposed to believe 'that in those villages the people were unusually negligent in 'watering the saplings, and that first the trees died of thirst and

'then the white-ants devoured the dead wood, as is their ordinary 'practice. A scientific forester had told me that white-ants attack- 'ed only dead wood, and hence my scepticism as to the statement 'of the villagers ; but I am now convinced that the saplings in 'many cases die of white-ants and not of other causes, that the 'attacks of the white-ants on the roots are the cause, and not 'the effect, of the trees drying up."

"The cause that led me to this perception of the truth is that 'I have attempted to raise a row of half a dozen mango trees close 'behind my bungalow, and I have had a number of the saplings 'die, they being in most cases attacked by white-ants. I have 'dug up three of the trees in different stages of the white-ant 'disease. One of the plants was almost dead, and it would have 'been difficult to prove that the white-ants were not innocent 'scavengers, removing useless dry wood. *Another tree was half-* 'dead, and the theory that exonerates the white-ant from the 'charge of devouring living timber, could only be maintained by 'crediting the termite with a marvellously accurate prophetic 'instinct that told the scavenger which of the trees were already 'doomed to die and might be removed as useless, for the tree 'was not yet dead but only likely to die shortly. In the third case 'the tree still looked quite green, save for a suspicion of unhealthi- 'ness about some of its leaves, and on digging it up I found that its 'roots had been eaten through in places by white-ants, and that 'a detachment of the voracious termites was actually pushing its 'way up the heart of the sapling, eating its path through per- 'fectly good, juicy wood. The sight of a channel about ⅛th of 'an inch wide thus eaten out up the very centre of a sapling, 'appeared to me to be conclusive proof that the mango tree was 'dying from the attacks of white-ants, pure and simple, and that 'the theory I had heard put forth in the name of Science by a 'Forest Officer, was untenable. That theory appears to me to con- 'fuse two cases : (*i*) that in which white-ants attack young trees 'a few feet high, eating out the heart of the tree, full of sap 'though it is, and doing their work of destruction unseen below 'the surface, and (*ii*) that in which white-ants ascend the *outside* 'of a tree in search, presumably, of dead branches on top.

"The attacks of the first of the above kinds are not confined 'to young trees. I have found fields of *tur* in which a number of 'the plants have withered owing to the roots being eaten up by 'white-ants, and in gram fields also I have had similar damage 'pointed out to me."

"If, then, it be considered as proved, that white-ants do con- 'siderable damage to horticulture by attacking the roots of living 'trees, the question of finding some preventative against their 'ravages becomes one of practical importance. I have made en- 'quiries as to remedies against the attacks of termites and found 'that the popular preventatives are numerous and not usually 'efficacious."

"The cultivator starts with the belief that the white-ants 'have a delicate sense of taste or smell, and exercise their ingenuity in inventing nauseous mixtures with which to water 'the suffering plant. Water, in which fish has been allowed to 'decompose, is believed to be as almost as strong in efficacy 'as in stench. Solutions of salt or tobacco are about the most 'popular of remedies. The *àl* dye I have heard of in this connection, but it is not thus used locally. The burying of *gur* in a 'hole near the tree, in the hope that black-ants will be attracted 'thereby and will incidentally eat up the white-ant colony, has 'been put forward by villagers. I have also been told to utilize 'the fact, that bears are greedy eaters of white-ants, and to soak 'a bear skin in water and put the termites to flight by applying 'the resulting liquor, highly impregnated with the smell or taste 'of their enemy's skin."

"None of these proposals are believed in very much by the 'people. I have myself tried a decoction of salt and tobacco 'with some effect, but the young trees are not thriving on the 'diet any more than the white-ant is. The question of finding 'a cheap and efficacious remedy is, I submit, worth an enquiry 'over a larger area than I have been able to arrange for."

Note on the Cultivation of Black Pepper in Assam.

BY B. C. BASU.

It is not perhaps generally known that black pepper is cultivated as a garden crop in certain parts of Assam. The writer of the article on black pepper (*Piper nigrum*) in Dr. Watt's Dictionary of Economic Products, does not mention its cultivation in Assam; the only reference made in that article to Assam is to the effect that black pepper is doubtfully indigenous in the forests of this province.* I have found black pepper being grown in many villages in the Sibsagar district. It is chiefly found in some villages in mauza Gadhuli Bazar in the west of the Sadar subdivision. In this mauza is a village, Jalukgaon, named after the Assamese word for black pepper. It is currently reported to have been the chief seat of pepper cultivation at one time. In Lower Assam the cultivation of black pepper is reported to be unknown. On the other hand, a little of it is to be found in Sylhet and on the southern slopes of the Khasia Hills, bordering on that

* From enquiries I have made, black pepper does not appear to occur in the wild state in any part of the Assam Valley, but an allied species (*P. longum*) the *pipal* or long pepper, is so found.

district. The crop is not, however, cultivated to any appreciable extent in any part of Assam. It is usually cultivated to supply the cultivator's own requirements, and what is left over after meeting his own wants, is sold. The aggregate quantity of black pepper produced in Assam is indeed very small, and very little of it finds its way to the market. Assam continues to derive its supply of this spice chiefly from Calcutta, although there is no apparent reason why it should not grow the whole of it, and have more to spare.

The black pepper vine is known in Assam as *gách jaluk*, and the spice locally produced as *guti jaluk* or *bári jaluk*, the latter name owing its origin to the fact of the spice being the produce of an Assamese *bári* or homestead, as distinguished from the usual commercial product, which, from its being sold by shopkeepers, is known as *golar jaluk*. Only one variety of cultivated black pepper is known in Assam. The Assam pepper seed is slightly smaller in size than the foreign product which comes through Calcutta. The indigenous article is, however, more pungent, perhaps because it is more fresh, and, therefore commands a higher price in the local market.

In Assam, the black pepper vine, like the betel vine (*Piper betel*), is usually grown on betel-nut trees (*Areca Catechu*). Mango (*Mangifera indica*), jack (*Artocarpus integrifolia*), and other garden trees are occasionally utilised for the purpose; but of all trees, betel-nut is regarded as the most convenient and suitable for raising *pán* and black pepper. It is planted immediately around the raiyat's homestead, and receives more manure, labour and care than any other tree or crop grown by him. The rearing of betel and pepper vines in association with this tree entails but little additional labour on the cultivator. The plucking of the leaf in the case of *pán*, and of the ripe berry in the case of black pepper, is also very convenient when these are grown on the betel-nut trees, as by the simple application of a ladder every part of the vine can be easily and quickly reached.

The pepper vine is raised either from suckers which spring up from underground roots or from shoots from the stem. Shoots, when used, are bent down into the ground to strike root before they are severed from the mother plant. The young plants are taken out with their roots at the beginning of the rains, and transplanted at the foot of the trees on which they are intended to grow. Generally, only one plant is put down at the foot of each tree. The slender stem of the young vine requires in the beginning to be carefully tied on to the supporting tree. As it grows up, it throws out from each joint numerous bunches of short, claw-like adventitious roots, which penetrate into the

soft outer bark of the supporting tree, and give the vine a firm hold upon the latter. New shoots and suckers continue to appear, and, growing up the tree, envelop it in the course of a few years with a dense mass of foliage.

The subsequent treatment of the black pepper plant cannot be distinguished from that of the betel-nut tree, with which it is mostly associated. Like the latter, it requires to be very liberally manured. Cowdung and household refuse are the only manures in use in Assam, and of these as much is given as the cultivator can afford. The manure is applied at the end of the rains and at intervals all through the cold weather. It is simply heaped up round the base of the tree on which the vine grows, and affords nutrition to both. The manure heap serves the further purpose of protecting the vine from cold and drought. To keep in the moisture in the manure heap, pieces of the thick juicy bark of a plantain tree are ranged round the base of the tree and renewed from time to time. A betel-nut plantation, whether *pán* or pepper be grown there or not, must be hoed, and cleaned once in the year at the close of the monsoon rains; a careful cultivator would repeat the operation thereafter and until the rains again set in, as often as he could spare time and labour for the purpose. The ground should be kept as clean and free of jungle as possible at all times of the year. In May, the manure heaps are levelled down and spread over the ground, otherwise they would absorb too much moisture and cause the roots of the vine to rot.

The pepper vine is very susceptible to drought, which often proves fatal. Rain and fog in the cold weather cause the leaves to fall off, and are consequently dreaded by the cultivators. The plants then remain bare until the first warm showers of April, when new leaves re-appear. Hailstorms are a frequent source of injury to black pepper and other crops in Assam. Some damage is also caused by a species of caterpillar which feeds on the leaves of the pepper vine. When it appears, it is destroyed, as far as possible, by hand-picking.

The black pepper vine begins to bear in from three to five years after planting, and continues to yield for at least twenty years. In every plantation, there are usually one or more vines which neither flower nor fruit. These are called *matá* or males, and the rest which bear fruit are known as females. The vine flowers in May, and the berries are plucked in December. They are gathered when just beginning to ripen. If allowed to ripen fully, they fall off and are picked off by birds. Pepper is cured in two different ways. If intended for the cultivator's own use, the berries would be boiled in water for a few minutes in order to soften the husk, which would then be removed by rubbing the

berries over a bamboo basket. The spice so prepared is of a whitish colour, and more pungent than the kind prepared for the market. For this latter purpose, the berries are simply dried in the sun after boiling, and allowed to retain the husk, which assumes a black colour, and gives the black pepper of commerce its distinctive name.

The produce of a vine varies with its age and size and the character of the season. The highest outturn that can be obtained from a single vine is said to be about three seers of dry cured pepper; the average yield is commonly reported to be about one seer for each vine in a plantation. The retail price of Assam black pepper varies from 10 annas to a rupee per seer, and the wholesale price from Rs. 17 to Rs. 20 per maund. An acre of betel-nut plantation can hold about 500 trees, and if each tree had a pepper vine on it, the annual yield of pepper alone from the plantation might amount to over 12 maunds, valued wholesale at Rs. 200 to Rs. 250.—(*Bulletin of the Agricultural Dept., Assam*).

V—SHIKAR AND TRAVEL.

A Cave Exploration.

In the Jaunsar Division, about a dozen miles beyond Chakrata, is a hill some 9,000 ft. high called Moila, queen of the surrounding country, and this queen is very hollow inside, as though she had nothing to eat, but it is evident she drinks too much, for the drainage of some acres of her crown all goes down what would be her gullet, if it stood alone in the business, but there are several competitors. One or two of these are more or less marked by dirt and débris. One is a nearly vertical hole which we had not time to plumb, but intend examining at a future time, as it certainly goes down a long way. The cave we examined is a vertically semicircular opening in a hollow at the foot of a small cliff or ridge. The rock is Deoban limestone, or a similar rock containing included fragments which is found in the Mundali series. As the whole drainage of perhaps 10 acres goes down this hole, and the rainfall is heavy, it is evident that the effect of water-action for centuries must have been considerable. The entrance is low and necessitates a stooping attitude, the passage enters straight for some yards and then turns to the left, or West, leaving a blind branch on the right. Next there is the choice between two courses, an upper and a lower. The lower means simply crawling under a rock, with the possible loss of waistcoat buttons and of portions of cuticle from the scalp and shoulders. The upper means climbing over a ridge and results in the discovery of a high vertical chamber, up which it is

possible, by the aid of suckers on one's feet and hands, to climb to some height There is no object in doing this, for we took all the stalactites and the stalagmites that were worth having, and a lot that were not. Both these courses unite immediately, and the passage now develops into a large vertical fissure with a floor about 4 feet wide. There is here another blind branch ascending to the right and it is rather curious. The branch is at first wide and high, but suddenly the wall comes down to the ground in front, leaving a slit about 10 inches or a foot high. There is a little window, but no glass in it, and visitors are allowed to put their heads through, but no more. We laid ourselves out very flat and passed beneath with a certain amount of grunting. Once inside, we imagined ourselves in one of the towers of a mediæval castle, for we were in a circular or polygonal space, with vertical walls extending to a considerable height, and the resemblance was completed by a few signs of bats. We might have lived here a month without paying any rent, which was a great temptation to good Oirishmen like ourselves, but our friends were waiting, an operation they eventually became quite expert at. On this occasion our party consisted of Capt. and Mrs. B., my friend B. B. Osmaston, I. F. S., and self. We two latter had visited the cave twice before, and had this time come prepared with beams, ropes, axes, picks, candles, sealing wax, paper trail, dynamite, and all things necessary for Alpine excursions. My friend, B. B. O, is a big man and a bad, I mean bold, whereas I am of small physique, and would rather fight a man of gigantic intellect and retiring disposition like myself, than a nasty, coarse bear, or a hasty and inconsiderate tiger. Consequently it fell to my friend B. B. O., to lead the van, and he nearly fell through the floor of it twice, as will be seen presently. I was rather disappointed there were no bears inside, because there was really no room to pass ; and I felt spoiling for a good fight, which I could have directed admirably from the top of some high stalagmite, or if necessary from the pendent end of a large stalactite. My friend, B. B. O., rather wondered at my continual admiration of stalactites which he considered of a dirty mud colour, and somewhat inaccessible and unwieldy to carry away. I did not trouble to argue. If he could not see their great points himself, who was I to explain their advantages. Well, as already explained, my friend B. B.O. led and I came next. Suddenly, his candle turned pale and he exclained, "by Jove, I put my foot over nothing!" "Did you?" said I, running into him with a bump. I always like to verify people's statements. He had, however, got his elbows firm into the rocks, and a sharp snag supporting his ribs, so we renewed the exploration cautiously. The floor of the cavern had certainly disappeared, so he stayed where he was. There was, however, a ledge above the chasm, and it was

practicable, if somewhat slanting and slippery. We tied a lantern to a rope and I let it down, finding the depth 20 feet and a shallow pool at the bottom. Further illumination showed that the far end of the chasm was practicable, so we fixed a post across, tied a rope to it, and my friend B. B. O., still in the van, went down it like a monkey. He reported that the passage continued, and started gaily along it while I was screwing up my nerves to descend too. At about the second step he again put his foot on nothing, and as I was not close behind, he was able to come back to report it. I got down, and as before, got a little along the chasm till I was sure of getting a clear fall for at least two seconds if I wanted it, and then with my friend's assistance, let down the lantern. Down, down, into the darkness, till I felt very small indeed. Who was I, to straddle a chasm like that? However, everything has an end. The rope had two, and I had hold of the second and last, so we fetched down our last hope, tied it on, and had about 6 feet to spare when the lantern reached bottom. Depth, 80 feet. These ropes would not bear my friend B.B.O., and I was determined they should not bear me, so there was nothing for it but to haul up the lantern, and ourselves, and clear out, which we did. The only signs of life we found were a spider's web, some planorbis shells, and a few bat's droppings. We hope next year to take an 80-feet rope ladder and see why the big chamber leaks, as it certainly does, for no water was visible at the bottom. The natives say that no man has ever been inside, but two dead sheep, taking fortune at the flood, once ventured in, and their horns, or sausages, or something, came out in the Bhingar nala; but that locality is a thousand or two feet lower down, and I hope it is not true, or our 80-feet ladder will not be much good. But it is exceeding likely. We thought ourselves pretty deep, but we could not get to the bottom of that.

F. GLEADOW

VI.—EXTRACTS NOTES AND QUERIES.

A big Teak Log.

We have recently been favoured with a copy of the Inspection Note on the forests of the Ruby Mines by the officiating Conservator, E. Circle, Upper Burma, Mr. J. Nisbet. From it, we extract the following :—

"Messrs Darwood and Company have now in one of the 'floating streams the largest teak log I have heard of. It is an 'old log but thoroughly sound, and measures 82 ½ feet by 10 feet '*mean girth=8 ¼ tons.* The butt girth is between 12 and 13 feet, 'and the top girth between 7 and 8 feet. The Local Government 'have been informally addressed relative to securing this fine 'specimen of a Burmese teak log for the Imperial Institute in 'London."

A log of 516 c. feet will be somewhat difficult to transport.

Indian Podophyllum.

A complete examination is now being conducted in the laboratories of the Scientific and Technical Department, of the constituents of the Indian plant *Podophyllum Emodi*, with the object of ascertaining how far the constituents resemble those of the well-known American drug *Podophyllum peltatum*, from which the resin called "podophyllin" is obtained and largely employed as a medicine in this and other countries. The inquiry is not yet completed, but it may be useful in this stage to give some account of certain of the results obtained, which seem to point to the conclusion that Indian podophyllum is an important drug, whose constituents are the same as those of the American plant. It produces similar medicinal effects to those of *Podophyllum peltatum*, whilst the Indian plant appears to furnish a larger percentage of the valuable resin. The investigation was commenced in the Research Laboratory of the Pharmaceutical Society, and has since been carried out in the Laboratories of the Imperial Institute.

The resin "podophyllin" was first prepared from the Indian root (rhizome) by the process of the British Pharmacopœia, which consist in exhausting the drug by percolation with alcohol, concentrating the percolate, and precipitating the resin by the addition of water. The resin so obtained is washed with water and dried by exposure to the air. The "podophyllin" is much lighter in colour than that made from *Podophyllum peltatum*; this was found to be due to the large quantity of the colourless crystalline substance "podophyllotoxin," which it contains (30 per cent.), while the commercial American resin contains an average of about 20 per cent.

The medicinal action of the resin obtained from the Indian plant has been examined by Dr. H. W. G. Mackenzie, of St. Thomas's Hospital, and its effect compared with that of the American resin.

Dr. Mackenzie finds that the two resins are identical in their medicinal effects, and that, therefore, there is no reason why the resin obtained from the Indian root should not be substituted for the American resin.

This is an important result, since the Indian root contains from two to three times as much of the valuable resin as the American root, and is, therefore, the more satisfactory source of the resin.

The following is a tabular statement embodying the results of estimations of the resin in the American plant, and in several specimens of Indian drug collected in various localities :—

(a) *Podophyllum emodi* :—

Name of District in India yielding the Root.		Percentage of Resin found.
Kulu	... ...	9·55
Bashahr	... ...	9·003
Chamba*	.. ...	11·12
,, †	... ...	12·03
Hazara	... ...	9·06

(b) *Podophyllum peltatum.*—Four commercial specimens of roots gave—

(1.) 4·17 per cent.
(2.) 5·2 per cent.
(3.) 5·4 per cent.
(4.) 5·2 per cent.

A complete account will shortly be given of the chemistry of the two plants, and of the nature of the substance to which the resin (podophyllin) owes its medicinal power.

Wyndham R. Dunstan,
Director, Scientific Department,
Imperial Institute.

28th November, 1896.

Imperial Institute Report, 1896-97.

A Natural Non-inflammable Wood.

The rapid growth in popular estimation of Australian timbers, during the past quarter of a century, is remarkable when contrasted with the opinion held of them, even in their native country, in earlier times. The early settlers, accustomed

as they had been to the use of pine and other easily-worked woods, regarded the gum tree as the most worthless of all timber. It was hard to split, and would not even make good firing. This last assertion, however, was true only of some species. The notice of Australian woods in England was no doubt due to the great Exhibition of 1851. It was shortly after the closing of this Exhibition that the Admiralty authorities instituted inquiries for the purpose of determining the most suitable wood for the construction of warships, and the verdict was given in favour of the West Australian jarrah. It was at about this time, however, that it was discovered that ships could be constructed of iron. But for this discovery, probably the wooden walls of old England might now be constructed of Australian woods. As a fact, wood for the construction of ships gave place to iron, and the report was almost forgotten. Later, however, jarrah was used for paving, and it is perhaps in consequence of this report that jarrah has always been considered as the most valuable of all the eucalypts. But the jarrah (*Eucalyptus marginata*) is only one in a large division of the Eucalyptus family. Scientific observers recognise about 170 different species of eucalypts in Australia and the islands immediately adjacent, but the practical bushman divides the family into three great classes which he calls gums, stringy-barks, and iron-barks. There is one characteristic of the stringy-barks which does not, as yet, appear to have received the attention it deserves. In all the official reports issued in the various colonies, it is said that stringy-bark does not make good firewood. As a matter of fact, this wood will not burn as other wood does; and in some parts of South Australia and New South Wales, where forests of stringy-bark exist, the settlers have some difficulty in finding wood to cook with. The bark, when stripped off and dried, will burn, as will the leaves, but the timber cannot be burned without being mixed with some more inflammable wood. Hitherto the reputation of this class of timber as firewood rests almost entirely on popular opinion, as no official tests have, as yet, been made with a view to testing how far the wood of the jarrah, the *Eucalyptus obliqua*, the *E. piperita*, *E. macrorrhyncha*, and other stringy-barks will resist fire. Some of the white gums and the "half barks," *i.e.*, trees which have fibrous bark on the stems and smooth bark on the limbs—are also very difficult to burn. Logs or sticks of these woods when placed on a fierce fire char through very slowly, and the charring goes on only as long as a fire, fed with inflammable wood, is kept up against them. When this firing is removed, the stringy-bark logs or sticks become black and cold at once. No other known wood exhibits this power to resist fire to the degree that the stringy-bark does, and therefore a suggestion in the *Timber Trades Journal* that official tests should be

made with a view to a scientific statement, as to the extent to which this timber is capable of resisting fire without artificial treatment, may be of great value. The discovery of a timber which may be used for internal fittings without danger by fire has engaged the attention of architects and others for some time past, and numerous methods of treating woods for the purpose of rendering them non-inflammable have been suggested. Many of these experiments have been made with that most inflammable of all timbers—pine. Whether they would have been more successful had they been made on a timber like stringy-bark, which has a natural power of resistance to fire, cannot be said positively, but its probability cannot be doubted. Stringy-bark is reported to be very sensitive to moisture. Hence, although it is easily worked, can be smoothly planed and takes a good polish, it is liable to warp, when exposed to damp. The warping takes the form of a swelling of the fibres so as to produce small ridges on the surface. How far this would be detrimental to its use for internal fittings must be decided by experts, but there can be little doubt in the mind of any person fully acquainted with the characteristics of this wood, that its use as joists, or for staircases, would enormously reduce the losses by fire in cities. Staircases and lift-wells form natural chimneys in case of fire, and if these were lined with timber as difficult to burn as stringy-bark is known to be, by practical bushmen in its natural state, fires, which now burn out a whole building, might perhaps be confined to a single floor or room, or prevented altogether.
—*Timber Trades Journal.*

ADANSONIA DIGITATA.

THE

INDIAN FORESTER.

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The biggest tree in Berar.

The picture, which we present to our readers this month, is a photograph of a big Baobab the (*Adansonia digitata*) at Karwand in the Buldana District, Berar, which we recently received from the Conservator, Mr. C. Bagshawe. The tree, whose size can be gauged by the figure of Mr. Bhukan, Extra Assistant Conservator of Forests, who is standing in front of it, is 42 feet in girth.

SILKWORMS.

ORIGIN OF THE SILKWORM.

The silk industry first appears to have been introduced into Southern Europe towards the beginning of the 14th century. Its place of origin, however, is China ; and indeed; if history is to be believed, it would appear that as long as 4,520 years ago the Chinese Empress, Si-Ling-Chi, did much to encourage the development of the silkworm culture in that country As might well be expected, the Chinese were extremely jealous of this, their new industry, and in order to keep the trade in their own hands, strict laws were passed punishing with death any person discovered in an attempt to remove this precious insect from the country. This expedient was so far successful that the secret was kept in China for over 20 centuries. In the year 140 B. C., however, a Princess of the House of Han, having been betrothed to the King of Khotan in Central Asia, was able to take away with her to her new home, concealed in her hair, the seeds both of the silkworm and of the mulberry. Thus the silkworm culture was first started in Central Asia. Thence it rapidly spread; and, as already stated, it reached Italy and France in the 14th century. Everything appears to have been done at that time to encourage the

new industry. So much so that in the ancient edicts of Florence, orders are to be found prescribing the compulsory planting of mulberry trees.

These few remarks must suffice as regards the origin of the industry in Europe. Further, it is not proposed in these articles to give any minute description of the different species and varieties of silkworms, or to enter into careful details regarding their anatomical structure. But a few brief notes regarding the life-history of the insect, and of the different stages through which it passes, will be necessary in order to fully appreciate the different points to be attended to in the construction of the breeding-house, and in the rearing of the insects as practised in the South of Europe.

The silkworm belongs to the order of the Lepidoptera, to the family of the nocturnal Lepidoptera, to the tribe of the Bombicydæ and to the genus Sericaria (Lat, sericarius, silk worker). The older naturalists have termed it *Bombyx mori*, a name which has been more recently altered to *Sericaria mori*. The egg, the larva, the chrysalis, and the moth are the different stages in its life-history, which it will be necessary to consider.

The Egg.

To begin with the egg stage. It will be found that the egg or "*seed*," as it is called, varies in shape, colour and weight both at the time of its laying, and during the period of its incubation. Thus, when first laid, the colour of the egg is generally a lemon-yellow. But between the eighth and fifteenth day it alters considerably in colour, passing through various shades, until it assumes a greyish colour, dotted with black points. In this condition it remains all through the winter, and through part of the spring, and until the time comes for its being hatched, when it again passes through various shades of colour, finally becoming a semi-transparent greyish white—a sure sign that further developments are at hand.

Again, the weight, even of the same breeds, varies very considerably according to the year, and to the locality. Thus, from experiments carried out by Professor Nenci it was found that one grain or ·035 oz. in weight contained from 1,330 to 2,190 eggs. Again, the loss in weight of the egg, from the time of laying to the time of hatching, varies considerably; the loss being put down at 14 per cent. of its weight at the start.

It may be interesting to mention here that the egg both inspires and expires; because by measuring the respiratory activity of the eggs, it may be shown that the life of the egg can be divided into three stages. The first stage, a period of about three months, full of activity; the second stage, from the end of October to the middle of February, one of sleepiness or lethargy, and during this period respiration is at its lowest.

Finally, the third stage, from the middle of February up to the time of its hatching, when vital activity again recommences. The following table from experiments carried out by Duchause, showing the quantity of oxygen consumed at different periods, will give an idea of the degree of respiratory activity at different periods, *viz.*:—

Age.	*Temperature.*	*Activity.*
1st day	... 21°C	... 13·8.
2nd „	... 21 „	... 26·0
3rd „	... 20·5°C	... 19·0
4th „	... 21 „	... 8·9
6th „	... 21 „	... 7·0
13th „	... 21 „	... 4·7
1st month	.. 21 „	... 3·2
2nd „	... 20 „	... 2·3
3rd „	... 11 „	... 1·0
7th „	... 7 „	... 1·4
9th „	... 8 „	... 2·9
Eve of hatching	... 28 „	... 48·0

Such is the history of the fertilized egg. But in the case of those eggs that have not received the necessary vivifying impulse, the egg changes its colour in an abnormal manner; the sides become compressed, until they almost touch; the inside dries up; and finally the whole decomposes.

The Larva.

The egg stage of the Bombyx has now come to an end, the larva is ready to make its appearance into the world; and to enter into the second stage of its life-history. Accordingly the imprisoned larva proceeds to swallow the last remnants of the centre, including the few small membranes which bound it; and, aided by a special saliva, it eats through the micropyle of the shell and thus comes forth into the light of day. Such is the birth of the worm. But this birth does not take place at any hour of the day. It is found that the worms generally make their appearance in the early morning between the 6th and 9th hour. Then, again, if a given number of eggs are being treated, it will be found that the period elapsing between the appearance of the first and last worm will vary from three to six days. Further, a percentage of from 15 to 20 of the eggs will be found to be barren.

At its first appearance, the little insect is but a microscopical object. It only measures some two millimeters in length, and over 2,000 of them are required to make up a gramme in weight. It does not, however, lose any time to increase its bulk. And, almost as soon as it is born, as soon as its mouth organs are

hardened, the Bombyx at once begins to nibble at the leaves of the mulberry, its favourite food. From this time forward its whole life may be described as one merely of feeding and digesting. It feeds day and night ; and, in fact., at all hours. And, indeed. the caterpillar has no time to lose, for in a period of about one month it has to increase 14,000 times in bulk. Thus the Bombyx may be said to visibly increase hour by hour, and at the same time it becomes of a lighter colour, due chiefly to the hairs occupying a larger superficial area.

At the end of a few days, however, a marked change appears. All this activity appears to come to an end, the caterpillar almost stops feeding, and as a result shrinks to a certain extent, and likewise becomes of a still lighter colour. Not only this, but it begins to roam about in an aimless manner, until at length it settles down on some suitable leaf or twig. To this it attaches itself by the claws of its false legs, and still further secures its body to it by means of silk threads.

In this position it remains quiescent for a short period, varying according to the temperature. After a time the caterpillar begins to move its head in a series of jerks, until at length its mouth parts are thrown off, and the caterpillar pushes itself out of its original covering, through the aperture thus formed, assisting itself in this process both by its thoracic legs, and by means of what may be termed vermicular movements. This process is termed a moult. To further understand this process, it is necessary to add that, at the time of moulting an exudation appears between the old epidermis and the new-formed one, thus materially facilitating their separation. This moulting is a veritable crisis in the life-history of the caterpillar. For during this process it changes to a certain extent its respiratory and its digestive organs, its skull, its organs of mastication, and, in a word, all those hardened tissues which could not keep pace with the prodigiously fast growth of the caterpillar. This moulting has, consequently, not incorrectly, been termed, "the sickness," because it is apt to kill off all weakly creatures; and strong and weak alike are during that period more subject to disease.

The Bombyx as a rule undergoes four such moults or sicknesses, though in some cases only three are seen. The period during which this process lasts is about 24 hours in the case of the first three moultings ; and varies from 36 to 48 hours for the fourth and last. Thus, the life of the caterpillar may be divided into the following 5 ages :—

First age ...	From	birth to first	mutation	... 5—6	days
Second age ...	„	*first to second*	„	... 4	„
Third age ...	„	second to third	„	... 4—5	„
Fourth age ...	„	third to fourth	„	... 5—7	„
Fifth age ...	„	fourth to fifth	„	... 7–12	„

The second age is thus seen to be the shortest; and the last age the longest.

For a short time after each moulting—perhaps just the time required to regain its strength, and for the new outer tissues to harden, the caterpillar remains practically in a "torpid" condition. Its head during this time becomes a darker colour, and its body is of a reddish or greenish yellow colour. But this state of affairs does not last long. It soon begins again to feed ravenously, and so continues until the time comes for its next moult. After its last change the caterpillar consumes an enormous quantity of leaf, until on completing its growth it begins to lose its appetite and finally completely stops feeding. Then for a period of about 24 hours it passes through what may be termed a "sleep of silk"—it lies motionless, and its only function is that of *thoroughly emptying out its digestive tubes, losing in this process* 12 per cent. of its weight, and becoming of a transparent yellowish or whitish colour.. Not long after, it appears to wake up from its slumbers. It grows very restive, moving its head about from side to side; and soon starts roaming about, until after much searching it eventually settles upon some suitable corner, and at once begins to wind itself round with threads of silk. At first the threads are apparently placed in an aimless manner from side to side—these however, are merely the ropes which are to hold the cocoon. Soon, however, the caterpillar is seen to move its head in a more regular manner describing curves of 8, and the shape the cocoon is assuming is clearly visible. It has been calculated that in this manner the silkworm moves its head 69 times per minute through a distance of 5 millimeters. The covering becomes thicker and thicker, and after a period of about 72 hours the work is finished, and the silkworm is completely enveloped in its golden covering of silk. Thus the cocoon is formed.

The Cocoon.

The cocoon varies in the different breeds both in colour and in shape. Thus the cocoon may be white, yellow, green, round, waisted, oval, &c. The cocoon consists of two parts, an outer lining or web, known as floss, which was spun by the worm in first getting its bearing; and of an inner part, the cocoon proper.

The whole is made up of one continuous thread. But, the thread of the floss diminishes in diameter from the interior towards the exterior, whereas the thread of the cocoon proper diminishes in diameter towards the interior; so much so that the ends of both cannot be made use of.

This diameter, as well as the weight of the cocoons, varies according to the breed, to the sex, and to the conditions under which the insects, have been brought up. As a rule, in the same breed, female cocoons would be heavier than male cocoons.

A few measurements may, however, be of interest; though it must be remembered that these measurements vary even in the same species.

The thread is said to have a mean diameter varying from a 7- to a 15-thousandth part of a millimeter. Its length in a cocoon varies from 1,312 to 3,608 feet according to Haberlandt; and from 1,312 to 4,920 feet according to Robinet. Moreover, it is so light, that 3,750 metres would be required to make up a gramme weight. In other words, one ounce of silk would represent a length of thread of 5,590,909 feet. In Southern European breeds the cocoon becomes of a darker colour towards the centre, whereas in the Japanese breeds the colour would be darker towards the exterior.

Robinet gives the following percentages as the composition of the cocoon, *viz* :—

Water	... ...	68·2 per cent
Silk	... ...	14·3 „ „
Web	... ...	0·7 „ „
Chrysalis	... .	16·8 „ „

The cocoons continue to lose in weight from the beginning to the end, this loss being considerable, as will be seen from the following table :—

During the first 8 days	... 40 per cent.
During the next 14 days	... 10 per cent.
During the last two days	... 25 per cent.

THE CHRYSALIS.

It has been stated above that at the time the worm proceeded to retire behind its silken covering, it had become of a white, wax-like colour; in addition, the different joints soon become more marked and the epidermis becomes almost transparent. These characteristics become more pronounced during the first few days of its imprisonment, until on the 4th or 5th day the skin cracks down the back, and the insect forces itself out through this opening, the old skin remaining as a folded membrane, round the last abdominal rings.

But the insect which has now appeared is in many ways quite a new creature. It appears to be without head or legs; its colour has changed; its skin becomes quite hardened; and rudimentary wings folded over the breast can be distinguished. This is the "*Chrysalis.*" In the same way vast changes occur in the internal structure of the insect, chief among which may be mentioned the development of an air bladder, and of the reproductive organs.

The Chrysalis stage lasts from 18 to 20 days, though it is found that by increasing or diminishing the temperature, this period of time may be altered.

The Moth.

This metamorphosis having been completed, the covering splits near the head, and the moth, the insect in its perfect form makes its appearance.

The moth has now to force its way out of the cocoon. To enable it to do this with ease, the larva when constructing the cocoon had left a false opening at one of the ends of the cocoon, an opening merely covered by a few threads. In addtion to this the moth secretes from its mouth a strongly alkaline liquid with which it moistens this thin end of the cocoon and thus forces its way out without breaking the threads. The birth or appearance of the moth always takes place in the early morning, probably so that it may without delay obtain the full benefits of the sun for as long a period as possible. And, indeed, it is sadly in need of a drying, *for on its first appearance* it is quite damp, its wings are crimped and damp, and its antennæ are bent back. Under the influence of the sun all this is soon remedied and the moth takes to flight.

Sometimes the females are the first to make their appearance; sometimes the males. But, it is generally found that in the end the two sexes are fairly evenly represented.

The moth naturally has a distinct head, throat and abdomen; and is of a light yellow or greyish colour.

The wings of the male are from 1·57 to 1·77 inches in length; whereas those of the females are slightly larger, 1·97 to 2·08 inches. *The males have broader antennæ than the females.*

Soon after issuing, the moths couple, remaining coupled for two or three hours, and in a few minutes, or it may be 4 or 5 hours after separation, the female begins to deposit her eggs, one by one. The eggs when being deposited get covered with a gelatinous material, which causes them to adhere to the surface on which they are placed.

The female goes on laying as a rule for 3 days; six to eight-tenths of the eggs are deposited during the first day, two or three-tenths during the second, and but few during the third day, one *female laying from 300 to 700 eggs.*

The reproduction of its species having thus, as far as possible, been assured, the moth has no further object in life. It therefore dies, the male generally having preceded the female.

Thus it has been seen that during a period of about 65 days, the silkworm has travelled through its different stages of life: 8 to 12 days in its perfect form, a moth; 15 to 20 days as a chrysalis; and 30 to 40 days as a larva—and some insight has been obtained into the physiological exigencies of the Bombyx. In a future article it is proposed to give some details regarding the method of *housing the insect so as to adequately meet its many and varied* requirements; and, further, to describe the best method of rearing the insects.

A. C.

Insect Ravages in the Goalpara District, Assam.

The charcteristic feature of the earthquake of the 12th June 1897, was the series of, more or less, deep and wide crevices and fissures, running longitudinally, with and in the vicinity of river beds, irrigation channels, roads, paths, &c. This feature was absent along rivers in the waterless tract of the Forest Reserves, except where such beds happen to flow perennially, no indication being visible where the flow was subterranean. As the existing record * makes conspicuously

* 1893-94 ...	...	150·77 inches.
1894-95 ...	...	117·68 ,,
1895-96 ...	...	142·57 ,,
1896-97 ...	...	122·16 ,,
1897-98 ...	...	188·84 ,,

obvious, the rainfall of the year was much in excess of that of any of the previous five years, floods were continuous and aggressive, yet the submergence and consequent killing off of Sâl, Khair and Koroi (*Albizzzia procera*) in normally inundated areas of this tract was considerably under the average. In the same region, too, windfalls and derelicts were not more numerous than usual, and the upheavals of trees so prominent south of the area, was not a feature of it. The higher and steeper slopes of the Bhutan Hills were scarped in numerous places and over a large area, but individual landslips were surface ones only, and did not carry any great tonnage with them. The cold weather was erratic, but snow fell in the hills to a greater extent than usual, covering a much greater surface and apparently of greater depth. This was especially the case early in February. The after-effects of the earthquake on vegetation beyond forest limits were visible in the unevenly distributed moisture in the coarse grasses which proved so troublesome in firing traces, &c., and whether these were extended or not to entomological phenomena, the season from that point of view, has been the most interesting one, of which any record has been kept.

The complete defoliation of Sâl throughout the district reported in 1893-94 was repeated again this year. About the close of August a *Dasychira* appeared in the Hèl and Charaidaka blocks, and despite the heavy rainfall, persisted. Adverse circumstances did not permit of much expansion, however, till a new generation manifested itself in the following November, at this time other varities of caterpillars appeared and the area affected extended over the greater portion of the Ripu Reserve, and commenced an attack on Chirang. But a third generation, about the close of January, was the most mischievous, and invaded almost every Sâl tree throughout the Division. Thus a mere mass of upright bare poles, without a vestige

of foliage, was the aspect of the forests early in March, except for a few young Sâl trees near the Bhutan border on the west of the district. When the leaves of the trees should have fallen, none were left to fall, all having been devoured by the active pests feeding on them. The inflorescence, which usually appears about the close of January or early in February, was conspicuous by its absence, not through having provided food for the larvæ, but for want of development. New shoots and leaves only appeared in March, and were permitted to develope till the close of the month, when, they too, fell to the voracious maw of the invader, possibly a fourth generation. The result is that there is practically no Sâl seed this year. Other trees suffered as well as Sâl, but to an insignificant extent, except the small stock of *Terminalia tomentosa* at the west of the district, which was stripped of all foliage like the Sâl. The pests did not completely disappear till May.

There was some difficulty at first in obtaining specimens of the pupa and imago, rain and parasitical hosts having possibly disposed of most of them. Specimens of larvæ sent on two occasions to Calcutta, unfortunately died before it was possible to rear and identify them, except in one case. Rearing was then attempted locally, and the imago of three varieties sent to Calcutta. They had been damaged in transit, and the identifications are doubtful, as reported by the courteous Superintendent of the Indian Museum, who has been most kind in affording information.

The first moth reared was the *Leucoma diaphana*, Moore, an insect not hitherto known as destructive to Sâl. It is very common in the district, and it is very doubtful whether it took any part in the defoliation of Sâl. It was, however, very conspicuous at the time of the first appearance of the Dasychira.

Dasychira sp (but not the *Thwaitesii*), was the prominent and most active agent in the denudation of the forests. It is so like the *Thwaitesii* in appearance that it was confounded with it for a long time. No less than four generations of it attacked the foliage. Its vigour and numbers were marvellous, but some destructive parasitical agency never left it, and whilst swarming in thousands, large numbers were observed to be in a moribund condition, which attracted red ants, and then destruction proceeded apace. The Guma Reserve alone, about 26 sq. miles, was a mass of Sâl foliage and inflorescence in March, prognosticating an excellent seed season, when this particular enemy, visible before, but only in numbers to be ignored, swarmed into the reserve with a vitality which left it as bare as forests further east, by the close of April. Caterpillars were collected on the 23rd March, passed into the pupal stage on the 30th and 31st March, and the mago emerged on the 20th April, 1898.

An agent as active as the *Dasychira*, almost as numerous, and working almost contemporaneously with it, was the *Lymantria grandis, Walk.*

The caterpillar is very hairy, of an ashy-brown colour overlying a darker hue, with two conspicuous tufts on the first segment of the body. It is about two inches long, possessed of immense vitality, and seemed a healthier subject than the *Dasychira*. It has not been previously observed here, and though a few specimens found their way to the Chirang Reserve, the majority favoured the Ripu and Guma Reserves. Caterpillars collected on the 23rd March, passed into the pupal stage on the 30th and 31st as did the *Dasychira*, but the metamorphosis into the imago was more rapid, occurring on the 10th, 11th, and 12th April.

The other specimen named was the *Trabala Vishnu, Lef.* but this insect was *not conspicuous in numbers or energy. Numerous* other larvæ were at work in the general defoliation.

The damage done to Sâl by these continuous attacks must be serious. Assimilation and development is arrested, numerous young shoots and twigs die, and it is obvious that a number of the unsightly knots on branches have their origin in this manner. Poor soils and shallow exposed situations and ill-grown trees are first attacked, but depredations are not limited to these, and it is astounding how complete the defoliation is, when not a vestige of a leaf is left. Numbers can only be imagined from the area worked over, which in Reserved Forests alone, exceeds 500 sq. miles.

From careful enquiries made from "the oldest inhabitants," &c., it would appear that these invasions have been more frequent and destructive since fire-protection was introduced, and the Division's records would appear to bear this out. The first mention of the pest was that made by Mr. W. R. Fisher, in 1878, and then there is silence for ten years. The next reference is in 1892. It is both possible and probable that some interesting episodes of intervening years have not been recorded, but any unusual manifestation could not have passed without some notice. Wholesale fire-protection was *only attempted in 1888-89, but even over Sâl areas was hardly* effective till 1891, and it is since then that defoliating insects have returned annually in larger or smaller hosts. Another effect of fire-protection has been the partial substitution of woody for fibrous undergrowth, and this is encouraging the growth of Millettias, Bridelias and Derris, which are making portions of the forests impenetrable.

Last year's Sâl seedlings have thriven considerably, and the extension of the tree as noted in previous reports is conspicuous. Most other trees produced seed profusely, but the period and duration of the inflorescence were not strictly normal; in all cases, the tendency being to late development. The orchids usually prominently in flower throughout the whole of May, were

nearly a month late; and the inflorescence did not last for more than a fortnight. This was typical of most trees.

"Eaux et Forêts."

The following is a translation of a report addressed to the President of the French Republic by the Minister of Agriculture, and of a decree relating to the denomination of Forest Officials, taken from the *Revue des Eaux et Forêts* for May 15th, 1898.

Report.—"*Eaux et Forêts*" are two terms, united by the relation of cause to effect, two words which, taken together, formerly appeared to constitute but one. From time immemorial it has been instinctively felt that between "*les eaux*" and "*les forêts*" there existed a close bond of mutual dependence, and that apart from the produce furnished in the form of wood and other material, the forests rendered signal service in storing rain water and in regulating the flow of springs, streams, and rivers. The Forest Administration has, therefore, been called upon to take action not only in respect of wooded areas placed under State management, but also in respect of a certain number of questions concerning the management *des eaux*; such for instance as the prevention of clearing private forest-lands, the re-afforesting and consolidation of mountain slopes, and the controlling of torrents. Its duties in this respect have recently been extended, and by a decree dated 1st July, 1897, it has been entrusted with the preparation and execution of works for utilizing for agricultural purposes the water of of forest and pastoral regions. Under these conditions, I am of opinion that it is expedient to confer on Forest Officers ('agents et préposés') the title of Officers of the "Eaux et Forêts," under which title they were formerly known. It is also necessary, by constituting a single list, to ensure unity of action and interest in the department charged with the supervision. This is the object of the subjoined decree which I have the honour to submit for your sanction.

The President of the French Republic, on the report of the Minister of Agriculture, *Decrees*:

I. Officers of the Forest Administration are designated Officers of the "Eaux et Forêts."

II. The members of the protective staff are borne on a single list of overseers, all having the same professional and military duties, and the same powers for the protection of the forests, and for the prevention of forest offences under the jurisdiction of the Administration of the "Eaux et Forêts."

III. The President of the Council, Minister of Agriculture, is charged with the execution of this decree.

Paris, 19th April, 1898.

III.—OFFICIAL PAPERS & INTELLIGENCE.

Impregnation of Indian timbers.

This question has on several occasions been under consideration, and various attempts have been made to impregnate Indian timbers, but, for one reason or other, the experiments were discontinued.

2. The following is a short résumé of what has been done up to date, as given by Dr. Warth.

Impregnation with creosote.

An apparatus for impregnating railway sleepers with creosote was set up at Bally, near Howrah, by the East Indian Railway and was in existence in April 1854. In appears that the process was given up because the hard woods of Lower Bengal were not adapted for impregnation, and no suitable soft woods were available in large quantities. Moreover, the creosoted pine sleepers from England were probably cheaper. Nothing further of any moment has been done at Bally since 1863. About the year 1868 or 1869, the East Indian Railway erected an apparatus on the pneumatic principle at Aligarh to impregnate chil *(Pinus excelsa)* sleepers with creosote. In 1874 it was reported that the sleepers treated with creosote were lasting very well. No steaming or artificial drying was practised, and the result obtained would seem to indicate that, even without this, the process is sufficient to considerably increase the durability of this otherwise very perishable timber. The reasons why the process was given up are not stated. A creosoting apparatus was etected at Sahibganj about the year 1870 and another at Bareilly, concerning which no information is available.

IMPREGNATION WITH PERCHLORIDE OF MERCURY.

About the year 1868 an apparatus for kyanising sleepers was imported by the Great Indian Peninsular Railway and a few soft wood sleepers were impregnated, which were found to be in good order at the end of four years. The process was discontinued as sleepers thus treated were found to be no cheaper than those made of teak.

IMPREGNATION WITH CHLORIDE OF ZINC.

In 1864-65, works for treating sleepers with chloride of zinc were set up at Kotri on the Indus, but the work was stopped in 1867. The result is reported to have been most unsatisfactory. About the year 1868-69 an apparatus for the pneumatic impregnation of sleepers with chloride of zinc was set up at Phillour. Some deodar and chil sleepers treated by this process were used in the railway line between Amritsar and Delhi, but the renewals in four years amounted to 6 per cent. In 1874 the apparatus was for sale. It is believed that the chloride of zinc was not very effective. However, the ballast used in the railway line is said to have been very inferior.

IMPREGNATION WITH SULPHATE OF COPPER.

In 1866 a certain number of chil and deodar sleepers were impregnated at Ghaziabad with a solution containing 3 per cent. sulphate of copper, under a pressure of 150 lbs. per square inch. They were placed in the Jumna bridge, and in 1870 it was reported that they were lasting well. The reason why the process was discontinued is not stated.

In 1865-66 Boucherie's process of impregnating with sulphate of copper was employed at Palghat on the Madras Railway. The woods experimented on belonged to 44 different kinds, all growing in the forests of the vicinity. However, the engineers reported that the strength of the timber and its durability were rather lessened than increased by the process, which was accordingly abandoned.

The results of the experiments hitherto made in India as here recorded are not conclusive. Much money has been spent without adequate results, but it does not follow from the numerous failures that have been experienced that if persistent efforts are now made to impregnate timber in India with antiseptic substances, the result will not be favourable. But it is essential that only good and effective methods should be adopted under competent supervision, and that the experiments should be continued sufficiently long, on a systematic plan, to show in what respects they require alteration and improvement.

3. Dr. Warth in 1878 proposed the establishment of a factory at Delhi or Jagadhri and in the Dehra Dun for impregnating

chil sleepers, but the proposal was not accepted at the time. However, circumstances have since then materially altered and there is now a largely increased demand not merely for railway sleepers, but also for scantlings of the better classes for building. The species of Indian timbers, the resistance of which against decay is equal to the durability of their technical qualities, are limited, and some of these are again heavy and excessively hard and consequently expensive to transport and difficult and costly to work, with the result that after all these years but a very small number of them have been generally accepted as adapted for railway sleepers and Public Works.

4. It is true that by the introduction of pyinkado into the sleeper trade, the Forest Department have considerably widened the field of supply, and there are probably other trees in Assam and in Burma which will be found equally useful. However, though undoubtedly large forest tracts, rich in pyinkado exist, especially in Burma, we can never be quite certain that the supply will be able to cope for ever with the steadily increasing demand. Moreover, the cost of transport of this heavy timber limits the area in which it can be profitably used. The report on the timber trade in the Punjab shows clearly that we must sooner or later expect a contraction in the supply of deodár timber from the forests of Native States, and consequently a material rise in its price. Again, the area of timber-bearing sál forests is but limited, and here also the weight of the timber limits the area in which it can be profitably used.

5. On the other hand, we have large forest areas yielding timbers structurally quite strong enough and fit for all the purposes for which a few selected naturally durable timbers have hitherto alone been employed. First in importance come the Himalayan pines—*Pinus longifolia, Pinus excelsa, Abies Smithiana* and *Abies Webbiana*—the technical qualities of which compare, so far as they have been recorded, with the deodar as follows :—

		Average weight.	Average transverse strength.
Cedrus deodara	...	35	334
Pinus excelsa	...	30	...
Pinus longifolia	..	38	800
Abies Smithiana	...	30	...
Abies Webbiana	...	30	440

Experiments with these woods as regards the resistance they offer to the separation of their fibres in various directions, should, as far as practicable, be made at the Forest School without delay and the results reported.

We have next a considerable supply of assain (*Terminalia tomentosa*) in the forests of the North-Western Provinces,

Assam, &c. The techical qualities of this timber compare with those of sal as follows :—

	Average weight per cubic foot.	Average transverse. strength.
Sàl	38—65	800
Assain	58—65	800

Again in Burma we have vast forest areas of eng (*Diptero-carpus tuberculatus*), the physical qualities of which are all that can be desired and compare with those of teak and pyinkado as follows :—

	Average weight per cubic foot.	Average transverse strength.
Tectona grandis ...	40	600
Xylia dolabriformis ...	69	900
Dipterocarpus tuberculatus	54	750

I have only enumerated a few species of which large supplies exist, but there are many others equally useful but for their liability to early decay.

6. Hitherto we have been using the accumnlated stock of trees in the timber of which technical qualities and durability have been fairly balanced ; but everything said in the foregoing paragraphs seems to indicate that the time has arrived when, in order to meet a steadily inereasing demand at reasonable rates, energetic steps should be taken to protect other timbers equally useful as regards their physical qualities from premature decay, by impregnating them. There is hardly a country where this has not been done and where constant progress is not made in doing so.

7. Before, however, I am in a position to place definite proposals before the Government of India and Local Governments, several points, which I am unable to gather from previous enquiries and notes, must be cleared up. I underastand that though somewhat smaller dimensions will be accepted to a correct lowest limit of 5″ 9″ × 6″ × 4″ for narrow gauge sleepers, and 8″ 11″ × 8″ × 5″ for broad gauge sleepers, it is desirable that the sleepers should be supplied of dimensions not less than 6″ × 7″ ×, 4½ and 9″6″ × 9″ × 5″ respectively. Our calculations should therefore take the latter figures into consideration, and we may roughly calculate the narrow gauge sleeper to contain 1¼, the broad gauge 3, cubic feet.

The first question to be asked and answered is at what *cost* can sleepers of such dimensions, and other scantlings per cubic foot of such timbers which it is desirable to impregnate, be placed in a central depôt, which should in every respect be suitable, both as regards supply and demand, for the establishment of an impregnating factory dealing with not less than 3 to 4,00,000 cubic feet per annum.

8. The next question to be settled is the selection of the impregnating fluid. Creosoted sleepers, that is, those impregnated with heavy coal-tars (phenol), have lasted extremely well in India; but this method, even in Europe, is twice as expensive as impregnation with metallic salts. Moreover, there *are considerable difficulties connected with the transport of* phenol, which apparently can only be safely imported in iron tanks. The cost of impregnating with imported coal-tar would in all probability be prohibitive, and it is a question for consideration whether phenol could not be prepared in India at a cost which would bring its employment for impregnation of wood within practical range. This question will be referred to the Reporter on Economic Products. The various kinds of timber will, under pressure and heat, absorb from 6 to 10 pounds of phenol per cubic foot.

9. *Of metallic salts, chloride of zinc has proved all round* the most successful, and is, moreover, the cheapest material that can be employed. It does not render the wood brittle like sulphate of copper does, and if used in sufficiently dilute solutions, 1 in 40 to 1 in 50, it does not react injuriously on the iron with which it comes in contact in the way both sulphate of copper and chloride of mercury do. The next question for the Reporter on Economic Products would be, what is the lowest cost at which chloride of zinc can be imported, and whether it might not be produced in India more cheaply and, if so, at what probable cost and where.

The chief objection to employing chloride of zinc is, that it is so extremely easily washed out of the timber. To prevent this, it has been mixed in America with solution of glue instead of plain water, and the timber has been subjected to a second impregnation with tannin extracts, which transforms the glue into a leathery substance unaffected by the action of water. This process has yielded the best results. It is a question whether glue in sufficient quantity, and at remunerative cost, could be obtained in India, and to solve this, the kind assistance of the Reporter on Economic Products would again be required. As regards tannin extracts, we can prepare these in any quantity required and at sufficiently low rates.

10. Experiments made in the School Circle and recorded in the Appendix Series of the "India Forester" for 1893, show that wood-tars have been made at a cost of Rs. 2-8 per maund, a rate which can probably be further reduced; and it is stated that with an admixture of $\frac{1}{3}$ of heavy coal-tar, it is nearly as adhesive and water-proof as pure coal-tar.

It must be ascertained whether this material could be permanently produced in sufficient quantity, and at what cost it could be laid down at a centre selected for an impregnating station. It is possible that the cheaper supply of wood-tar might render creosoting with this, or with this mixed with

coal-tar, practicable. Under any circumstance, it is most important to ascertain whether a partial impregnation, with a mixture of wood-tar and coal, of timber already impregnated with chloride of zinc, would not prevent the action of water on this salt.

B. RIBBENTROP,
Inspector-General of Forests.

SIMLA, *9th June* 1898.

Iron Smelting with Charcoal in Salem District, Madras.

The industry, if it is to be developed, I mean if the manufacture of iron is to be conducted locally, will have to be confined to the Tirtamalai beds. From the statement appended to Mr. Brasier's office-note, No. 2445, dated 23rd October 1897, he now estimates that within a radius of 16 and 25 miles respectively, there will be 224,250 and 288,642 acres of reserved and proposed reserved forests available for the manufacture of charcoal.

These forests have been less indented upon ; the growth is, for the most part, denser than in the forests near the Kanjamalai beds, and there is little doubt the average annual increment is greater. Mr. Brasier estimates the latter at three-fourths of a ton per acre per annum. This estimate will probably be realized, but in the commencement it will be safer to assume half a ton per acre per annum as the average annual increment.

The area mentioned previously will have to be reduced to exclude rocky, bare and unworkable parts, and 25 per cent. may be accepted as a fair margin. This reduces the workable area to about 168,000 and 216,400 acres respectively. Further deductions are necessary. Parts of these forests contain valuable woods which would not be felled for charcoal. In addition, in places, provision may have to be made for local requirements. It has also to be borne in mind that fuel as well as charcoal will be required. I consider it will not be safe to accept more than 120,000 and 160,000 acres (according to the adoption of the 16 or 25 mile area) as available for charcoal manufacture.

The average annual yield would therefore be 60,000 and 80,000 tons of wood, or 12,000 and 16,000 tons of charcoal (allowing 5 tons of wood to yield 1 ton of charcoal).

The system, generally, of working these forests would be coppice with retention of a percentage of the more valuable trees as standards, and it would not be advisable, until further experience has been gained, to adopt a shorter rotation than thirty years.

Mr. Brasier estimates the cost of the charcoal at *Rs. 12-12-0* for the 16-mile areas:—

	RS.	A.	P.
Cost of billetting, &c., 5 tons of wood at Rs. 1-8-0	7	8	0
Piling wood in kilns and general supervision ...	0	8	0
(I see no reason to question these. Mr. Brasier has had great experience and is well acquainted with the local rates.)			
Interest on outlay for rough cart-tracks	1	0	0
(Assuming that the outturn is only 10,000 tons annually, this would allow Rs. 10,000 for roads).			
Carriage of 1 ton an average distance of 8 miles, Rs. 1-12-0	2	4	0
(This is a doubtful factor and depends upon the position of the furnaces. I would increase Mr. Brasier's rate by As. 8 to allow for increased distances).			
Seigniorage	2	8	0
(Mr. Brasier's estimate is, I consider, too low. Annas 8 per ton of wood or Rs. 2-8-0 per ton of charcoal is not a high seigniorage).			
Sundries (loading and unloading charcoal) ...	0	8	0
Cost of general supervision	0	8	0
Total cost per ton of charcoal ...	14	12	0

One point to be noticed is the transfer of the work to the Tirtamalai beds entails carriage to the railway, some 14 miles.

(*Report by E. P. Popert, Conservator of Forests.*)

Report on the Cultivation of the Carob or Locust-bean Tree.

In the course of last spring a well-known gentleman from South Africa made enquiries at this Consulate concerning the cultivation of the carob or locust-bean tree and the possibilities of

its introduction into the Cape Colony. The carob is a tree, the fruit of which consists of a long pod which not only forms excellent horse-food but is very largely eaten by human beings, especially children, on account of its sweetness. The pods contain very hard beans which are useful only for seed, as horses leave them in their mangers, and if by chance they swallow them, it is found that they do not digest them. The tree bears, moreover, thick dark ever-green foliage which gives a cool and grateful shade. It grows in many places in the Mediterranean where nothing else will grow, notably on the arid hills of Malta, and it seems certain that in the endless varieties of soil and climate to be met with in the Cape Colony there must be many districts where it would grow freely. The successful result of such an experiment would be simply invaluable to the colony if merely as a supply for horse-food, for one of the greatest difficulties in travelling at the Cape is to feed one's horses, the price of forage in some districts being extremely high, and the supply often distressingly short. Forage, moreover, as it consists of oats with their straw, is not readily portable, but carobs enough for a pair of horses for a day can be carried in a small bag. The carob in Italy grows alongside the oranges and lemons, and there can be no reason why it should not grow with the magnificent orange trees of Wellington, and become as superior to the carob of Italy as the Cape orange tree is superior to its Italian prototype. In places like Graaf-Reinet, and Aliwal North, the success of the experiment seems absolutely certain, while, judging from the way the tree prospers on the dry stone of Malta, where it grows with apparently no soil to help it, there is good hope that it might take kindly to the "Kopjes" near Colesberg, the bush veldt of the Western coast, the lower slopes of Drakenfelds, or among the trees of the Knysna forest. The writer being well acquainted with the Cape Colony has had much pleasure in investigating the matter thoroughly, and, after lengthened consultation with practical arboriculturists, the following *modus operandi* has been decided upon. First, a sufficient quantity of seed will be sent out to grow a number of seedlings in different parts of the colony. These seeds will produce carobasters, which will not have a fruit worthy of the name till they are grafted. The strongest seedlings may be grafted in their third year, but it is of no use to graft until the plant is strong and well grown, which may not be till it is five or even seven years old.

A number of plants in pots will be grafted here next spring, re-potted in larger pots with plenty of clay, and when the grafts have taken well, the trees will be packed, the clay well soaked in water, and it is confidently hoped that they will bear the journey satisfactorily. They will be sent from here in the month of February, and will probably travel viâ England, which seems climatically preferable to the East Coast route by German steamer to Durban viâ Zanzibar. If the coincidence of the steamers can be secured they may reach Cape Town within a month of their

despatch from here, or even less, but if not, we have no doubt that the steamship company will see that the roots are kept carefully wetted while the trees are in bond at the port of origin. It is with the object of keeping the roots wet that they are now being repotted in stiff clay, a soil which is in itself favourable to the growth of the tree.

Having thus given a general sketch of the scheme, it is necessary for its success to enter into minute detail as to the method to be employed in the cultivation of the trees. We will first take the plants to be exported two years hence, because these are ultimately the most important part of the subject. If they should succeed, the acclimatization of the tree at the Cape is assured; if they fail, the seedlings will be comparatively valueless for want of grafts. It is the fixed opinion of people here who have studied the subject closely, that there would be no chance of grafts sent out arriving in a condition to be of any value whatever, so that it becomes absolutely necessary to send out the plants themselves; besides, when the plants at the Cape were ready to be grafted, our grafts would be out of season here. We have already secured some excellent plants, from each of which grafts should be available. It does not seem possible to secure plants already grafted, for the reason that they are not usually grafted in pots, the operation being performed after they are planted out and have got a good hold on the soil which is to be their permanent home. We cannot graft these plants till May, 1898, nor can we be sure of the success of the operation till May, 1899, when the plants will be sent out. The carob is a tree which cannot be transplanted on account of its tap-root, so that once planted it must remain where it is; it is therefore very essential to plant it in the right place to begin with. In the case of our plants it will be necessary to top them and to cut off every leaf, in order that the sap may not be exhausted by the foliage when it begins to rise. We shall consequently export mere skeletons to the colony, and here again we have another difficulty to contend with, namely, the change of season. The plants will leave here at the end of our winter, and will arrive at Cape Town at the beginning of the South African winter. They will thus have a great strain put upon their nature, and great care will have to be taken of them to enable them to overcome it. This care they will certainly have at the hands of the managers of the Botanical Gardens in the colony, so that this is one of the least of our anxieties. The details in this report would therefore be unnecessary, but for the fact that as the experiment will be tried on an important scale, and many of the plants will fall under the care of less capable hands, it is advisable to give very clear instructions. On arrival at their destination the plants must be carefully potted in garden mould, to which a little

old farmyard manure should be added, and the pots must be moved from time to time to prevent the plants striking a tap-root through the hole at the bottom of the pot into the soil, in which case they will certainly perish. They will not require very much water, in fact the climate of South Africa so much resembles that of Naples that, were it not for the clay which we must send with them, the plants would scarcely require water at all in the Cape winter. If, however, this clay gets hardened it may kill the rootlets which by that time will have spread into it, and give the tree a worse chance, so that the clay must be kept moist. It may be desired to plant the trees out at once, but this should not be done in windy weather, and on the whole it will be safer to pot them, at all events for a few months, till they can recover from their journey.

With regard to the seedlings, they should be sown in pots with proper drainage, and in garden mould, with a slight sprinkling of old, short, farmyard manure. The greatest care must be taken to move the pots often enough to prevent a tap-root being struck through the pot into the ground beneath. Experiments may safely be made by sowing seeds in the spots where they are intended to remain, and grafting them when the plants come to maturity, but this should be done in enclosed gardens or places where the plants can be guaranteed from being choked by weeds, nibbled by sheep or game, or otherwise harassed in their early years. The carob grows freely in dry soils, but, economically speaking, it has been found preferable to raise them in pots. The seeds will be sent out in the pods, as this has proved to be the best method for their preservation. It is desirable to remove the beans from the pods, and soak the beans for four days before sowing them ; the seed thus gets softened, and germinates rapidly. At Naples the seeds are sown in February and March, but they are apt to sprout very unequally. The majority grow freely and well, but some come up as late as October, and then generally develop weak plants. The strongest seedlings may be potted at the end of the first year, or even as early as November ; the weaker ones at the close of the second. They must be kept in pots till they are finally planted, as they will not bear transplanting, and windy weather should be avoided for these operations. The experiments conducted here show that it takes a minimum of four years and a maximum of seven to produce a plant. A strong plant may be planted out in safety in five years, but much depends on the skilful care of the seedlings in the nursery. Each plant brought to maturity in this country is calculated to cost 8*d*., and it has been found by experiments that it is cheaper in the long run to grow the plants in the nursery than to sow them in the open ground. They are not particular as to soil, and grow freely in clay, if not too wet, in sandy soils, and in the clefts of rocks, where of course holes of about a cubic yard must be dug for

them and filled up with soil, drainage being provided in the ordinary way. It is usually necessary to build a rampart of stones in the shape of a crescent on the lower side of the hole to prevent the soil from being washed away. On "Kopjes" and hill sides, the trees must be planted on such spots as offer a position, unless the hill has soil enough to be terraced, but in open arable land they should be planted in rows from 12 to 15 yards apart. The intervening ground can be used for garden crops, but these must not be grown within four feet of the young trees, although the ground round the trees may advantageously be dug over when the rest is prepared for cropping. Exhausting crops, such as corn and mealies, must not be grown, but cabbages and garden produce generally will do no harm.

It is better to let the plants obtain a strong growth before attempting to graft them, the third year being about as early as it is prudent to do it. If a plant is very full of leaf it is desirable to leave it alone and not to graft it at all, for a reason which will appear below, and also because being leafy it may be taken to be a good variety. The season for grafting here is from the middle of May to the end of June, the grafter being careful to see that the bark opens easily. The best plan is to graft on the boughs and not on the stem, leaving the smaller boughs to utilise the winter deposit of sap, which may otherwise prove injurious to the grafts. These boughs can be cut off in the following year. Then carob can also be satisfactorily budded, or grafted by sawing off the trunk and cleaving it. In windy situations it will be necessary to bind canes to the grafted boughs to stiffen them, and to prevent the grafts from moving. The best two varieties of carob are both called here the "Honey bag"; one bears a long narrow pod, the other a short wide one.

The object of leaving a fair sprinkling (say 25 per cent.) of ungrafted trees in a grove is the following. The grafted tree produces almost exclusively female flowers, the ungrafted tree males. Unless these flowers are in due proportion there can be no crop; and in fact this was the primary cause of the failure of a carob grove in Sicily, a cause which was discovered and remedied by Professor Bianca. In planting these trees on ordinary arable land, great inequality will often be found in the plants, which arises from the fact that the carob cannot support water. Hence, where water accumulates in the subsoil the tree will not grow, whereas, where the water drains away, it will grow freely, and for this reason a hill side is the best situation for a grove.

Some years ago the Italian Alpine Club agreed that it would be greatly to the advantage of South Italy, and would add materially to the attractions of the mountain scenery, if the Apennines, which are now for the most part quite bare, could be made to grow trees such as there is every reason to believe that they did in more ancient times. They determined to con-

sult Signor Savastano, the professor of aboriculture in the school of agriculture at Portici near Naples, who gave it as his opinion that the mountains where the lentisk and the myrtle grow freely enough could be utilised to produce the more remunerative carob. To the obvious advantage of re-afforesting the mountains, and thus adding to the rainfall, would be added the production of a valuable crop where nothing saleable had grown before.

The great carob-growing districts of South Italy are in the Bari region on the Adriatic coast, and quantities are exported annually to Russia and central Europe from Brindisi and the other ports along the coast. Though the tree may be seen in almost any garden here, and is not uncommonly found on the mountains, the only person who has made a hobby of its cultivation is the Prince of Belmonte, who has large properties in the province of Salerno not far from the ruins of Paestum. Besides planting several trees in his shrubbery, the Prince has a long avenue of them leading up to his house, which is particularly interesting, and is, we believe, the only avenue of its kind. The trees are planted 7 metres apart, and the largest of them has a trunk of 85 centimetres (about 2 feet 9 inches) in circumference. This tree is 18 years old, and its top is from 6 to 7 metres in diameter, and 4 or 5 in height. In common with the other trees of the avenue the fruit is of the best description, and each tree may be taken to yield annually 50 chilos, or say 120 lbs. of fruit, worth here about 6 shillings. This may be spoken of as the ornamental part of the work, while the plantations of Licosa and Tresina are more on the scale of a commercial enterprise. They are both germane to our present purpose, as they show in what different circumstances the carob will grow and flourish. The Licosa grove is in a plain by the seaside, and the difference of the trees is very remarkable, some of them growing with great vigour, others not flourishing at all. The reason of this must be the existence of land-springs beneath the surface with which the weaker trees come into contact, and by which their growth is checked. There is no other apparent reason, and as the grove consists of about 1,500 trees there is scope for observation. The site is very much exposed to the wind, and in the first attempts at forming the grove, as many as 70 per cent. of the plants were lost. There were other causes too, which led up to this heavy loss. First, the whole thing being an experiment, they did not know at what period and in what way it was best to graft the trees, and also the grafters had not anything like the skill which they have since acquired.

The grove at Tresina is planted in altogether different conditions. Here we have a hilly country fully 1,000 feet above the sea, and here the outside loss of plants has been 20 per cent. which is not more than occurs in the planting of ordinary forest trees. The plantation consisted originally of 7,000 trees, but has been largely increased year by year, and

the Prince expresses every confidence that in a few years' time he will clothe the barren slopes with a mantle of luxuriant green. Professor Savastano asks very pertinently why, if these results can be obtained at Tresina they should not be obtained elsewhere, and thousands of barren acres of Italian mountains be made useful and productive. And in fact, since he wrote upon the matter, the spread of this cultivation has been steady and continuous. We have shown pretty plainly that Prince Belmonte has attained success only by patient experiments extending over a considerable number of years. Commercially speaking he is abundantly satisfied with the results obtained, but he does not relax his efforts. He rears some 8,000 seedlings every year, and has a skilled staff to conduct all the necessary operations, with the result that he grows a valuable crop on ground which before was absolutely unproductive; and if the landed proprietors of South Africa profit by his experience and are equally persevering, and the tree, as is anticipated, proceeds to grow like a weed, its introduction should form a mine of wealth to our industrious colonists. There is one important advantage that the carob has over other beans, namely, that it does not require threshing. In feeding horses it is usual to break the pod into two or three pieces and to put it in the nosebag or manger, mixed with bran.

(*E. Neville-Rolfe, H. B. M's. Consul at Naples*).

Willow for Bat-making.

The following interesting information about the willow is taken from the "The Bat of the Victorian Era," by Geo. G. Bussey & Co.

The only willow that produces timber suitable for best bats is the *Salix alba*, and, moreover, only those grown in East Anglia are eligible.

The other branch of the Salicaceæ, the poplar, whilst its timber has much in common with white willow, does not possess the necessary fibrous tenacity for bat-making and it is also heavier. Although we have made researches practically the wide world over, we have not been able to discover any timber other than the willow of East Anglia that possesses sufficient toughness, combined with the necessary lightness, to produce best bats.

The "sets" (as the shoots are called) are cut from healthy trees, either maidens or pollards. Pollard is a term applied to a tree from which the tops have been lopped off. Each set

should be about 2 in. diameter, 6 to 10 ft. long, and as straight as possible. And here we may give a curious fact; the shoots must be of the close bark order if they are to grow good enough for "Demon Drivers." Open bark trees will not make "best" bats.

These "sets" are planted in rows about 12 ft. apart, along the banks of a stream or sides of a ditch. If placed in barren or unfertile land, where they cannot draw a plentiful supply of moisture, which is so necessary to the willow, their development will be slow, and the lines of growth, blurry and ill-defined. When, however, planted by the side of water which can percolate freely through the soil to the roots, their advance will be rapid, and the lines of growth distinct and well defined.

Formerly, willows were planted for no other purpose than to hold the banks of water-courses together, being selected because of their rapid growth. Landowners little thought that some 20 or 30 years later these despised trees would have a considerable intrinsic value, and bring a veritable harvest to the reaper. Had they realised this, we cannot believe they would have grudged the trivial expense of trimming the saplings to make the trees symmetrical and comely at maturity.

Cricketers have seen many beautiful blades disfigured by an ugly knot. This is the result of neglecting to cut off a twig when the tree was young, which might easily have been done with a penknife. The shoot sprouts from the side of the tree, when the trunk is say 6 inches in diameter. If it be not removed it continues to grow with the tree, which closes gradually around its base, and the consequence is that all the growth of the trunk from the 3 in. radius from the centre (the trunk having been 6 in. in diameter when the neglected shoot sprouted), is marred by a knot, curl, or twist.

Cricketers should, however, bear in mind that a blemish of this sort does not, unless it be near a corner, in any way shorten the life of a bat. A good piece of wood with a blemish is far preferable to a bad piece without one. Frequently a really good bat is placed on one side by a purchaser in favour of one with an appearance more to his fancy, but which will not, however, render him as much service as in all probability the rejected would have done.

The willow in the course of its growth is "heir to more ills" than most other timbers. It is a delicate sapling, much affected by its surroundings, and, consequently, requires more care and attention than it is necessary to bestow upon the sturdier British timbers.

A great source of injury to young trees which materially affects their future is the gnawing of the rind or bark by cattle. The bark is as necessary to a tree as the skin is to an animal, indeed more so, for it is in fact not only the tree's skin, but it is a source of its vitality, for wherever any bark is removed the sap cannot nourish that part and decay commences. The most

effective and speedy way of killing trees is by "ring-barking," that is, removing a bark from the trunk. This prevents the sap rising beyond the ring, consequently the part above soon perishes for want of nourishment and the tree dies.

Splendid trunks, too, are frequently spoiled by a dead or broken limb. When a limb shows any sign of decay, or a portion of it is broken by a storm, it should be cut off squarely, in such a way that water cannot be deposited, for such a lodgment would cause rot to set in.

There may have been noticed a peculiar horizontal marking on the blades of some cricket bats. The appearance might be described as "stainy." We have heard it called a "knot," but we do not acquiesce in this definition. Our theory is that this strange marking is due to a small aperture, probably made by a worm or other reptile boring its way through the bark into the trunk, which in some way or other changes the condition of the wood. The general opinion is that water trickling through the aperture causes the peculiar marking. We have invariably found that when there is this "stainy" appearance there is also a small opening from the outside leading to the close proximity of the mark.

Let the cause of the marking be what it may, it is, in our own judgment, of some value to the blade. It considerably adds to the surface strength of that part of the blade where it is found. Some cricketers are chary about choosing a bat with this marking, but we think they act quite wrongly. How often have you known a bat break by reason of it? The finest blades are produced from timber having this "stainy mark." Inferior quality timber rarely possesses it.

A tree steadily growing, in good soil, under favourable conditions, will be in 20 years about 45 inches round the trunk. The sacrificial axe may now do its work, although we should advise the owner to let the tree grow for many years still.

The willow is quick to grow, but its period of existence is relatively short, natural decay setting in much earlier than is the case with the more hardy timber.

An oak at the age of 100 years may be in its prime, but there are very few willows of this growth without a large hollow space in the centre indicative of many years' decay.

The proper time for felling is during the winter, the sap then being down. Should the tree be taken down when the sap is up, it will dry in the trunk, which certainly deteriorates the timber.

For many years our Mr. Bussey personally purchased the willow from the landowners, the timber being brought direct to our London factory, but having foreseen for some years that good willow was becoming scarcer and scarcer, we determined that our patrons, at any rate, should not have cause to complain of the quality of the material used in the "Demon

Driver," and we conceived that the best possible plan for us to adopt would be to purchase all the really A 1 timber we could discover. Now this plan necessitates large storage room, and although we have extensive yards at our London factory, we decided to erect timber mills in the very heart of the best willow growing district. As the result, we have our timber mill and yard, covering two acres, at Elmswell, Suffolk, which are under the charge of one of the most competent judges of willow living.

Having the necessary accommodation the next step was to stock it with willow. Our expert then commenced literally to search the country; and there is probably not an owner or tenant of rural property in East Anglia, but who knows us as buyers of good willows. The outcome of these efforts is that we have a holding of the finest timber without parallel in the history of the cricket trade, exceeding 1,000 tons. Even now we have no intention of relaxing our efforts; every tree we can find which we believe will produce good bats we shall buy.

At Elmswell, Messrs Bussey have their own plantation of saplings, from which, in years to come, they hope the sons of our present readers will possess bats as good as the "Demon Drivers" of this year of Jubilee.

(*Timber Trades Journal*).

The Forest Department in Madagascar.

The Official Journal of Madagascar of the 15th January last, publishes an important circular of the Governor-General relative to the preservation of the forests of the colony. Circle Commandants are required to assist in the execution of Forest works relating to, nurseries, fire-protection, clearings, fellings, etc., and in places where the forest staff is insufficient, which is generally the case.

"No fellings are to be carried out without previous sanction and when the fall is to consist of wood at less than one metre in girth, the Forest Department must first be consulted for such material constitutes the forests of the future. The Natives must gradually be accustomed to respect the property of others and must no longer be allowed to consider as their own special property the forest domain, the limits of which are every year receding before the action of fire and the axe."

One recognizes in these measures the administrative spirit of General Gallieni, and the zeal of the Chief Forest Officer, M. Girod Genet, who has an excellent article in the 'Journal' of the 22nd February, on reafforestation in Emyrne where wood is very scarce.—*Revue des Eaux and Forêts.*

Epiceine.

The following short account of Epiceine is taken from the '*Revue des Eaux et Forêts*' for the 15th May.

Epiceine is a condensed extract from the *Abies excelsa.* It is obtained by distillation under a pressure of four atmospheres from freshly cut branches of Spruce Fir. This preparation is an ideal balsamic drug. It contains all the extracts obtained from the Silver Fir which have been so strongly recommended in diseases of the respiratory organs and the urinary ducts.

Epiceine contains, in the same proportion in which they are found in the Spruce, tars, turpentines, essential oils, acetate of bornyl, phenol and similar products. The method of extraction based on the employment of the fresh plant explains the superiority of Epiceine over all similar preparations. Its value in the treatment of all affections of the respiratory organs is such as to have made it an accepted remedy in cases of coughs, bronchitis, inflammation, acute or chronic, of the nose, windpipe and lungs.

It appears not altogether improbable that the Forest Guards of the higher plateaux of the Jura who chew Spruce resin throughout their days' work, may be the real discoverers of Epiceine which is strongly recommended.

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Forest Schools and Model Forests in Scotland.

BY COL. F. BAILEY, R. E.

In 1881, M. Lucien Boppe (now Director of the French National Forest School), reported on the condition of our British woodlands after visiting them at the invitation of the India Office; and in 1896, Dr. Adam Schwappach, Professor of Forestry at Eberswalde, in Prussia, who came over to read a paper before the Royal Scottish Arboricultural Society, also recorded his opinions on the same subject. Both of these eminent experts of different schools of forestry, criticised us severely, the principal points noticed being the small extent of our woods as compared with the vast area of our uncultivated lands, our almost universal neglect to re-stock our woods by means of self-sown seed, and, above all, our practice of too early and excessive thinning, which results in the production of low, branchy and tapering stems, yielding a very insufficient crop of timber of inferior quality, as well as in the impoverishment of the soil.

Dr. Schlich, Professor of Forestry at the Indian College at Coopers Hill, and author of the Manual of Forestry, has repeatedly confirmed the above views. In the address on Forestry Education,[1] which he delivered to the Royal Scottish Arboricultural Society in January 1897, he said:—

"You are aware that the general drawback, from which 'forestry in this country labours, is the absence of a regular 'demand for home-grown timber. You also know that, until a 'comparatively recent date at any rate, most Government contracts 'for work of construction contained a clause to the effect that no 'home-grown timber would be allowed to be used. If we take 'these broad facts into consideration, it is easy to perceive that 'the explanation may be condensed into the following two state-'ments :—(1) The home-grown timber is, generally speaking, in-'ferior in quality to that imported from abroad; (2) it comes into

1 Transaction of the Society, Vol. XV. Part 2.

'market at irregular intervals and in fluctuating quantities. Ex-'ceptions exist, but here only the average conditions can be 'considered. These drawbacks can be removed only by improved 'sylvicultural methods, and a systematic management of the 'forests."

Writing on the Timber Supply of the British Isles,[2] Dr. Schlich gives as one of two impediments to the afforestation of waste lands, "that a more complete knowledge of systematic 'forestry is required by those engaged in the formation and 'management of woods worked on economic or commercial prin-'ciples."

Causes of Existing Conditions.

Many reasons may be given why we have in the past exposed ourselves to criticism of the above nature. We possess within our own shores, vast supplies of coal and peat fuel, also of iron, which is largely used for purposes of construction, while our islands offer remarkable facilities for the importation of timber from abroad. Hence the want of a plentiful supply of wood from home sources has not yet been felt; and proprietors of woodlands, many of whom have in past years maintained their woods principally as game-coverts and to increase the beauty of their estates, have not, generally speaking, wished them to be managed on commercial principles, with a view to profit.

Our practice of keeping woods more scantily stocked than such principles would unquestionably indicate, is, no doubt, largely due to exigencies of sport; but it may also be traced to the open condition in which alone crops of such widely-grown and important species as oak and larch can maintain themselves, beyond a certain age, unless they are mixed with other species of a different nature. These are, no doubt, the principal causes of the sylvicultural practices objected to by our critics; and in the absence of schools of instruction, and of woods where the results of improved methods might be seen, our faulty system has frequently been regarded as the only one suited to the conditions of our soil and climate.

On this subject M. Boppe says:—

"It would certainly not be fair to hold the Scottish foresters 'responsible for the present regrettable state of affairs, for, though 'they have for the most part admitted the inefficiency of the present 'system, they are powerless to effect any improvement so long as 'the landowners and general public have not learnt to appreciate 'the manifold advantages to be derived from a regular and methodi-'cal management. They have to struggle against many adverse 'interests and hindrances, such as grazing and shooting interests, 'questions of routine, pecuniary exigencies, and the fancies of 'sportsmen from all parts of the world."

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2 Indian Forester, June 1897.

This is undeniably true, the wood-managers and foresters having loyally and conscientiously carried out the policy of their employers.

Views held here on Continental Forestry.

In countries, such as France and Germany, where forests owned for centuries by the State, and managed on economic principles, cover vast areas, the sylvicultural systems pursued are based on the observation of facts, recorded throughout a long period of time by competent men of science specially trained to the work in schools maintained by the State. In those countries, correct views on systematic forestry are much more commonly held than they are here. With us, the subject is but little understood, and comparatively few people, even amongst those whose interests are the most affected, realise the degree in which forestry is truly a science. The recent publication in our language of scientific works on sylviculture has drawn considerable attention to the question of wood-management; and in 1895, a body of members of the Royal Scottish Arboricultural Society made a most instructive tour in the forests of Northern Germany; but it cannot be expected that the mere study of books, with rapid visits of this kind, useful as they are, can alone lead to a full comprehension of Continental methods, and to an adequate appreciation of the conditions under which one or other of them has been employed in a particular locality. Hence these methods and their application are sometimes imperfectly understood, and any suggestion that our woods might be treated under them, meets with objections, some of which at least would not be raised if a fuller knowledge of them prevailed. But there is no doubt that a conviction is rapidly gaining ground that all has not been quite right in the past; and a strong desire is now very generally evinced that practical proof should be given of the extent to which methods of treatment, successfully employed in other countries, are really applicable to our forests.

Reform is Necessary.

All doubts as to the sylvicultural methods most suited to the woods of our country should, long ago, have been set at rest by practical demonstration of what is here possible in the way of growing full crops of high-class timber under various conditions. We undoubtedly produce a limited quantity of timber of first-class dimensions and quality, but it is equally certain that our home-grown wood, especially pine and fir, is, for the most part, inferior in quality to that imported from abroad; and this is so far generally recognised, that home-grown produce, even of the best quality, is but little used in Government or in private works of construction. Indeed, until recently, the use of such timber

for the erection of buildings under the *Land Improvement Act*, 1864, was not permitted without the special sanction of the Board of Agriculture; and even now it is thought necessary to prescribe that when thus used, it must be of suitable dimensions and be cut from trees that are sound and of proper age and size. Again, the Postmaster-General, having been recently requested to try home-grown Scots fir for use as telegraph posts, replied,—"The 'results . . . show that Scots fir is less strong than the Norway 'red fir in general use by the Department. It is, moreover, less 'straight and less free from large and rough knots. Apart from 'the question of the comparative merit of the Scots and Norwegian 'fir, the difficulty and delay experienced in obtaining even small 'parcels of Scots fir suitable for telegraph poles renders it 'necessary for the Department to resort to the Norwegian market 'in order to obtain adequate supplies." And miners are known to pay high rates for foreign pit wood in preference to using poles grown near the pit's mouth.

But, while our consumption of forest produce is steadily increasing, and Dr. Schlich has shown, (1) that the value of our yearly imports, which amounts to about £ 18,000,000, has risen by about £2,000,000 during the past eight years, he conclusively proves, in his exhaustive paper on the Timber supply of the British Empire, that the permanence of our supplies from abroad is very far from being assured; and thus we may before long find ourselves face to face with a scarcity which must lead to an enhancement of the price of timber.

Again, the forest question has much greater importance in Scotland than in England; for the agricultural returns show that, out of a total area of mountain and heath land used for grazing, amounting in the United Kingdom to about $12\frac{1}{2}$ millions of acres, nearly $9\frac{1}{2}$ millions are in Scotland; while out of a total additional area of nearly 9 millions of acres of unused waste land and inland water, about $4\frac{1}{4}$ millions are situated in Scotland. It is not known what proportion of these vast extents of country is suitable and available for planting, though land of the lowest degree of fertility is capable of producing a profitable crop of coniferous timber, but it may safely be assumed that the existing woods, plantations, and nurseries, which cover little more than 900,000 acres, might be increased to at least four or five times their present area, without including a single acre of ground good enough to grow an agricultural crop. And such extensions would no doubt for the most part take effect in the Highlands, the more remote and poorer part of the country, where the increase of wealth and prosperity accompanying the presence of woodlands is already very noticeable, and where many hundreds of thousands of acres might be rendered as productive under

1 "*Forestry Education*," "*Transactions of the Royal Scottish Arboricultural Society*," Vol. XV, Part 2.

timber as much of the agricultural or pastoral land in England, which yields a nett income to its owners of not more than 5s. to 10s. per acre. We may, therefore, feel reasonably confident that the introduction of remunerative sylvicultural methods will lead to the area under forest crops being largely added to, and that we shall thus become less dependent, than we are at present, on supplies from foreign countries.

WHY WE REQUIRE MODEL FORESTS.

There seems no reason to doubt that the owners of waste lands, which might be suitably and profitably afforested, would be much more willing to plant than they now are, if a practical object-lesson could be presented demonstrating the methods by which a fair return on their outlay could be assured; and the sooner such a demonstration can be provided, the better for them, and for the country at large, especially for the class to whom extension of the wooded area would afford additional employment.

We require a Model Forest then, first of all, that we may be in a position to offer to proprietors, their wood-managers and foresters, a practical proof that the principles of economic forestry, as taught and practised in France, Germany, and other countries, are equally suited to our islands. It is, of course, well understood that the application of these principles does not involve hard and fast methods of treatment; and that French and German foresters regulate important matters, such as the density of planting and the degree of thinning, in accordance with the conditions prevailing in the locality they are dealing with. We want to demonstrate what method of treatment, under our own conditions of soil and climate, would lead to results similar to those obtained in other countries where the principles of economic forestry have long been followed. Dr. Schlich, in his address on Forestry Education, says,—"We are justified in concluding 'that there is no reason why just as good timber, as that 'now imported from abroad, should not be grown in this country, 'provided improved sylvicultural treatment and a systematic 'working of the forests are introduced." This cannot be doubted. M. Boppe speaks of the "marvellous timber-producing proper-'ties" of our soil and climate, and the "wonderful aptitude 'of (our) soil to forest vegetation, favoured as it is by a 'regular climate and the constant humidity of the atmosphere." He found growing, both singly along the roadside, and collectively in the forests, "magnificent specimens of oak, maple, elm, 'ash, beech and lime, which, by the vigour of their growth and 'the rich colouring of their foliage, bore testimony to the favour-'able conditions of soil and climate under which they grew." Speaking of the Dunkeld woods, M. Boppe says, "From a 'forest point of view, the results obtained by these two species '(Scots fir and larch) are truly marvellous;" and he adds; "It

'is, therefore, a matter of regret that nothing has yet been 'done to place forest management in Scotland on a sound 'economic basis." It appears unlikely that it ever will be placed upon a sound basis throughout the country until we have a Model Forest in which we can illustrate methods and point to results.

The *Model Forest is also required for conducting* experiments and researches, such as would enable our teachers of sylviculture to base their instruction on data obtained in this country, instead of relying on figures, the result of observations conducted elsewhere. Volumes I., II., and III., of Schlich's "Manual of Forestry" necessarily bristle with such figures; but, useful as they are, it is high time that we started records of our own, and work of this nature can only be done satisfactorily in a State forest, by men of special scientific training.

Again, we want a Model Forest as a field of practical instruction for students. Dr. Schlich writes,—"Something more 'is wanted than theoretical instruction. Instruction in the field 'must also be provided. There must be forests which are managed 'on the right lines, where students will find the theory of economic 'forestry practically illustrated." And M. Boppe expresses himself as follows: "The science of forestry is, however, a science of 'observation based upon facts which must be studied both from a 'practical and theoretical point of view. It is, therefore, absolutely 'necessary that a forest school should have, attached to it, a forest, 'which has for some time past been under scientific manage-'ment, serving, so to speak, as a natural laboratory for ex-'periments, and without which the best theoretical teaching in 'the world would be of no avail. This is especially the case in 'England, where the young men, by reason of their national 'character and their mode of education, are accustomed to pay 'more attention to facts than to theories; here the teacher 'of a technical profession, resting solely on theories, would com-'mand very few disciples. It is, therefore, a matter of regret that 'among all the forests visited by us in our travels, there is not 'a single one suitable for the teaching of sylviculture on that 'broad basis so essential when the pupils are called upon to 'supply it in all quarters of the globe. In England, as in Scot-'land, all the woodlands may be arranged in two categories—the 'one containing plantations too young, recently created by the 'hand of man; the other containing plantations too old, or too 'much overworked, to be useful for the purpose; nowhere 'did we see a high timber forest formed of really mature trees." Those who have for some time past endeavoured to carry on instruction in forestry without a practical training-ground of the kind above indicated, can best appreciate the want of it. The owners of Scottish woodlands have certainly most readily permitted teachers with parties of students to have access to their woods; and the benefit derived from such visits can hardly be

exaggerated; but it will be readily understood that, in this country "forests which have for some time past been under scientific 'management" are rare, and that even the best managed private forest estates lack that continuity of aim and action which alone can fit them in every respect for educational uses.

Forest Schools.

To train for the superior staff of the French State Forest Service, officers who are to be charged with the administration of about 11,500 square miles of State and Communal forests, a National Forest School is maintained at Nancy, with a staff of thirteen professors and assistant professors, who teach sylviculture, working plans, geology, mineralogy, entomology, botany, forest law, political economy and forest statistics, surveying, forest engineering and agriculture. The school is accommodated in spacious buildings, embracing residences for the staff and students, halls of study, recreation rooms, museum, library and chemical laboratory; and an area of 7,500 acres of forest in the neighbourhood is under the control of the Director of the School as a field of practical instruction, as well as for purposes of experiment and research.

In the German Empire there are eight superior State Forest Schools equipped on a like scale; and in nearly all countries of the European continent, schools of a similar kind are maintained for the training of officers for the Government forest service. A considerable portion of the Windsor Crown Forest is managed, for purposes of practical instruction, by the professor of forestry at the Indian Engineering College, Coopers Hill; while the Forest of Dean will, it is understood, shortly be brought under systematic management, and will thus also become available for instructional uses. But the students of the Forest Branch at Coopers Hill College still receive the principal part of their practical training in State Forests of France and Germany, which have been subjected to rational treatment for a long period of years.

Forests used as the main practical training-ground for students are always placed under the control of the Director of the school. Speaking of the area that should be provided for instructional purposes in this country, M. Boppe says:—

"This accessory forest must necessarily be incomplete at 'first, but would be perfected in time; but the essential point is 'that it should be placed under the absolute control of the 'officers of the school. This can only be done by choosing a 'State forest. If it should be considered desirable, also, in 'order to render the teaching more complete, the State ought 'to purchase or lease in Scotland, a forest suitable for the 'purpose." The chief reason for this is that if the estate were managed merely as an ordinary forest, it might not, and almost

certainly would not, serve in the best possible way as a field for practical instruction. To meet the latter requirement, work must be carried on so as not only to furnish an object-lesson in economic forestry, but also to illustrate in the fullest manner the course of lectures given to the students; and on this account the work carried on in a school forest will always be of a more varied nature than that in an ordinary forest, and its details must be arranged, as far as possible, so that the course of theoretical instruction may run hand in hand with it. These conditions would not be fulfilled unless the Director of the School had control of the forest.

THE FOREST SCHOOL IN EDINBURGH.

If we had a sufficiently large area of State Forests in Scotland, with a proportionately strong staff of Government wood-managers, a State Forest School, such as the above, would be a necessity; but existing circumstances hardly appear to warrant the immediate foundation of an independent school, at which, in addition to forestry proper, the necessary auxiliary subjects, such as botany, chemistry, geology and mineralogy, entomology, engineering, etc., must be taught by a special staff of instructors. Candidates for the Indian State Forest Service will continue to be trained at Coopers Hill; and although an independent forest school in Scotland would no doubt receive support from young men seeking Colonial appointments, the number of these and of students who might be expected, at the present time, to enter it with a view to employment in this country, would not be sufficient to provide funds for its maintenance. The only plan now feasible seems to be to teach forestry in some university or college, where instruction in subjects necessary to the complete understanding of the course is already obtainable: and this is what is now being done in Edinburgh. It is true that such an arrangement has many important drawbacks. First of all, it is not to be expected that, under it, the Model Forest, in which the practical part the course is given, will be situated in the immediate vicinity of the class rooms where the students assemble to hear lectures. And again, in a university or college, the auxiliary subjects are necessarily taught without that special reference to forestry which is so desirable, and which can only be secured at a special school. In such an institution students would be taught *forest* botany and *forest* entomology; geology and mineralogy would be treated with special reference to the formation of forest soil; chemistry in relation to the nutrition and growth of plants; and the engineering course would deal with simple surveying, timber measurement, the construction of forest roads, bridges and buildings, with saw mills, forest tramways, timber slides and other labour-saving means of moving timber, rather than with engineering in its general aspect.

We are not yet in a position to attain these advantages.

In Edinburgh, at the present time, three courses of lectures on Forestry are given, viz :—

First.—That delivered daily, during the winter session, at the University, usually to a small number of students who are following other courses, and who, for the most part wish to qualify themselves as factors to estate managers. The class has been attended by a few sons of landed proprietors, a few men who contemplated seeking a career in the colonies (though it is not known that any of these have left the United Kingdom), and by others whose aim was to become farmers and who elected forestry as one of the alternative subjects prescribed for the degree of Science in Agriculture. In addition to class-room lectures, these students are given such practical instruction as is found possible in neighbouring woods, saw-mills, nurseries, timber-yards, creosoting works, etc., the owners of which have courteously made them welcome. The course of lectures on Forestry at the University was opened by Professor William Somerville in the autumn of 1889; and since then the number of enrolled students has been 107.

Second.—Weekly evening lectures delivered by the University Lecturer at the Royal Botanic Garden, to a class which during the past winter numbered thirty-one students, of whom sixteen were foresters and the remainder were gardeners. The curriculum embraces chemistry, physics, meteorology, geology, surveying, mensuration, entomology, botany, forestry and horticulture; it extends over three years, during which time, about 40 lectures in forestry are given.

Third.—A course of lectures in forestry was commenced this year at the Heriot-Watt College—where during the winter session the University Lecturer addressed a class of thirty students, on one evening a week. The members of this class were for the most part clerks and law apprentices, who were qualifying for factorships with foresters, gardeners, nurserymen, and seedsmen; and among their other subjects of study at the College may be mentioned botany, entomology, mensuration and book-keeping, agriculture, agricultural chemistry, building, land surveying, and geology. They were employed in the city and neighbourhood, and could not attend day-classes, nor follow courses of study elsewhere.

Such is the work now being carried on in Edinburgh, where, during the current year, sixty-four students attended courses in forestry given by the University Lecturer, and were, for the most part, also studying auxiliary subjects at the institutions where the lectures in forestry were given. The course at the University is fuller than the other two; but its value would be very greatly enhanced if a Model Forest for practical instruction were available. Few of the students of this class have sought to follow the career of wood-managers; but they have evidently considered

that a knowledge of forestry would be useful to them in other occupations connected with land. It may, however, be reasonably hoped that, as proprietors come to realise the advantage of bringing their woods under a regular system of management, the prospects of wood-managers will improve, and that young men who may desire to follow this career will attend the University class as the best means of obtaining professional instruction available in Scotland at the present time. The establishment of an independent school of Forestry will, no doubt, follow sooner or later, as future developments may indicate; and when the time for this arrives, the Model Forests now asked for will have been for some years under preparation as a practical training ground. There can be no doubt that in existing circumstances the present classes meet a want. To men who have already been employed in woods, or who intend to become factors or foresters, an insight into the principles of economic forestry cannot fail to prove an advantage; and experience has shown that the foresters now in charge of Scottish woods take a most keen and intelligent interest in the subjects dealt with in the class-rooms, are quick to grasp new ideas, and eager to try changes in their accustomed methods.

It can hardly be doubted that the lectures given in Edinburgh during the past nine years have, amongst other influences—such as the Arboricultural Society's tour in Germany—had an effect on the opinions held by many persons in this country who are interested in forest management, and have had a share in removing the prejudice with which, until the last few years, innovations were generally regarded.

Location of the Model Forests.

At the present time, Edinburgh is the only place in Scotland where lectures on forestry are given; and there does not appear to be any immediate necessity for the establishment of lectureships at other centres. It is good policy to concentrate our efforts in one place, and to leave nothing undone to improve the facilities for teaching there, rather than to dissipate our strength in attempts to sustain the machinery of instruction in several places. Dr. Schlich entirely supports this view, for he says in his article on Forestry Education: "In my opinion, 'you would do better if you, at the start, were to concentrate 'operations, so as to make *one* definite scheme a reality, and 'that scheme should be to perfect the education of your future 'wood-managers, or under whatever title they appear upon the 'scene. *In other words*, I should advocate *one* centre of instruction, consisting of (1) theoretical instruction in connection with 'a university or agricultural college, where instruction in the 'auxiliary sciences is already provided; (2) woodlands where 'practical instruction can be imparted, because in forestry, theory

'and practice must go hand in hand. As regards the first point,—'theoretical instruction.—a beginning has been made in this very 'city [Edinburgh] . . . The arrangement needs only further 'development, and to be put on a proper footing, so as to bring the 'subject of forestry, as regards its importance, on a par with other 'branches of learning."

Edinburgh is not so far distant from any part of Scotland as to debar men living in the most remote counties from attending courses there; and in view of the fact that students, while attending the forestry classes, are either following other courses of study or are employed in the city, it is essential that the Model Forest should be situated within such a distance that they may be able to reach it and return on the same day, as they now do when visiting woods in the Lothians, Fife, and other places. It will not suffice to acquire bare land only, with a view to planting it, as this would involve waiting for a long series of years before anything but planting, sowing and the management of young crops could be practically dealt with. What we want is to obtain control of growing woods, or at any rate of areas which carry a large proportion of growing woods, of all ages, and of as many species as possible; and we should ultimately be able to deal with various kinds of soil, and various slopes, altitudes, and exposures in at least two different parts of the country.

Working Plan.

One of the first things to be done on acquiring an area to be converted into a Model Forest, would be to prepare for it a Working Plan, which wouldl ay down once for all the general lines of management to be followed, and would prescribe in some detail the work to be done during the first few years. Such a plan would be preceded by a survey of the growing stock on the ground, such as would enable the annual yield to be determined, and a programme of fellings would then be drawn up. Such a plan must form the basis of all systematic forest work. Without it, continuity of aim cannot be secured, or even hoped for, throughout the life of a generation of trees, which may exceed the working lives of several successive generations of foresters; neither can there be any security that the forest capital will not be drawn upon by fellings in excess of the annual production of wood.

The Manager.

To carry out the scheme in such a manner that the Model Forests may answer all the purposes above indicated, the services of a Manager of the highest professional attainments must be secured. On him will depend the success of an undertaking which it is confidently believed will have far-reaching effects on the manage-

ment of woodlands in this country, and lead to an important increase of the area. He must be thoroughly versed in the theory and practice of economic forestry, and it is important that he should not be a mere student but should have had considerable experience in practical work. He must be familiar with the French and German languages, so that he may keep himself abreast of the most recent developments of continental forestry. He must undertake the researches to be carried out in the Model Forests, and be familiar with the results obtained by other workers. It will be his duty to prepare working plans, and to inaugurate a system of records which will bring out clearly the results of his system of management, and enable the fullest possible use to be made of them by the proprietors and foresters of the country. Such relations must be established between him and the lecturer, or head of the forest school, at Edinburgh, *as may ensure the forests being made to answer instructional* requirements in the fullest manner.

Board of Visitors

A board of visitors should be appointed, who would report direct to the Board of Agriculture any suggestions that they might, from time to time, desire to make regarding matters affecting the management and use of the Model Forests.

Estimates and Provision of Funds

In regard to the funds necessary for the acquisition of the land and trees required for conversion into a Model Forest, it has been estimated that the cost of 1500 to 2000 acres of suitable land within reach of Edinburgh. and including some 500 acres of growing woods, averaging forty years in age, would not exceed £40,000; that the nett annual income from such an estate would not at first be less than £1000, and might be as high as £1500; and that this, with a temporary annual grant of £500 from Government, should be sufficient to meet all the charges of maintenance. It is not suggested that the State should grant the capital needed to acquire the land and trees. If the Government would effect the purchase, the property would, of course, be vested in the State, which would, in the course of few years, receive a perpetual revenue therefrom, representing at least a fair return on the investment. In the interests of the Edinburgh Forest School, it is imperative that this land should be obtained with the least possible delay.

In conclusion, it is necessary to consider the source from which the required capital can be provided. Why, it might be asked, should the land be *acquired* at all? Could not a proprietor be found who would be glad to profit by having his woods

brought under systematic treatment, and would thus permit them to be used for all our purposes? The answer to this suggestion is, that however ready a private proprietor might be to place his woods at our disposal, we could not rely on any privately-owned estate, as we could never be sure that any system of management which we might introduce would be continuously followed, nor could we even feel confidence that the forest itself would not be withdrawn from our use at any moment The ownership of private estates changes by succession or sale, and successive owners may desire to alter the object of management; while, in any case, they do not all take the same interest in their woods, nor possess the same degree of knowledge as to how they should be treated; and circumstances may even constrain a proprietor to follow a course which he knows is not that best calculated to improve his property. "But," it might be urged, "even so, the woods 'of Scotland are the property of private owners, who would 'benefit by any improvement the Model Forests might lead 'to. Let them provide the needful funds." But proprietors are not by any means the only class who would benefit by the introduction of system into our management; for if it could be proved that profits are assured, and if this led to an extension of the wooded area, our supplies of timber would be better secured than they now are, and employment would be given in country districts to a large number of people who would be very glad to obtain it.

The case has been cited of land-owners in *Bohemia and Moravia*, who have formed associations for providing professional education for young men who desire to enter their service as foresters. But they had a notable advantage over proprietors here, in that they had an object-lesson before them in the shape of forests managed on the best principles by a department of the State. Land-owners can hardly be expected to respond readily to a suggestion that they should put their hands into their pockets, until they can feel confidence that improved management will result in a degree of financial success hitherto unattained. The practical demonstration of this result is one of the principal objects we have in view when urging the formation of Model Forests; when once land-owners have become satisfied on this point, they will doubtless be willing to endow an independent national forest school.

It seems, therefore, reasonable to ask the Government to take the first step towards a much-needed reform in our wood-management, by providing a State Model Forest in connection with the existing School of Forestry at Edinburgh. The difficulties which oppose themselves to private action in this direction are so strong, and the importance of the interests involved are so great, that, it may confidently be said that of all enterprises to which the State might offer aid or encouragement, Forestry is that which has the strongest claims on the consideration of the Government.

The Cultivation of Gutta-Percha.

There are various classes of Colonial enterprise. Some give an immediate return, like the sugar-cane and vanilla industries. Others require a few years of work and investment before giving any return; for instance the less herbaceous and more woody crops, such as coffee, tea, and cocoa. The most woody crops, like Cinchona, rubber and gutta percha only begin to yield after some considerable period. Those who take up large domains in our new colonies will doubtless devote their first care to those crops which promise an immediate return, but they should certainly not at the same time neglect the latter class, and more especially rubber and gutta percha. Of late years, much has been heard of the various rubber trees. The conquest of Madagascar has brought the matter more within the region of practical questions. There are, indeed, in that island, several indigenous species of trees which furnish rubber of excellent quality, and there is room to hope that, with due care in exploiting the existing trees, and in making new plantations, the island may come to be a considerable and permanent source of rubber.

There is also gutta-percha, extracted from a different set of trees. Rubber comes from the Euphorbias (*Hevea*, *Siphonia*, *Manihot*, &c.), the Urticaceæ (*Ficus*, *Castilloa*, &c.), from the Apocyneæ (*Landolphia*, *Vahea*, *Kickxia*, *Hancornia*, &c.), and from the Asclepiads (*Caloropis*).* Gutta-percha comes solely from the Sapotaceæ. Baillon, in his "Medical Botany" and "History of Plants," gives a large number of species yielding gutta of more or less superior quality. The principal belong to the genera *Palanquium*, *Isonandra*, *Payena*, *Sideroxylon*, *Bassia*, *Imbricaria*, *Chrysophyllum*, *Mimusops*, *Sapota*, *Lucuma*, &c.

Among all these, four only are received in commercial circles, *viz*., the genera *Palanquium*, *Isonandra*, *Payena*, *Mimusops*, and *Sideroxylon*. The best gutta is that of *Palanquium Gutta*, H. Bn. (*Isonandra Gutta*, Hook.—*Dichopsis Gutta*, Benth.) growing in the Malayan Peninsula,† where there were once extensive forests of this tree, but they are fast disappearing before the wasteful practice by which the sap is collected. The Malays attack trees of about 36 inches diameter and 30 years old. These are felled clean for the sake of 250—300 grammes of gutta. The coppice shoots resulting may be cut at 15 years old.

In order to produce their annual 3 million kilogrammes of gutta, the Malays have to cut down more than 10 million trees. The price of gutta has doubled in the last ten years as the result.

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* Translator's Note—The juice of Calotropis appears to me to bear a much greater resemblance to gutta than to rubber. It becomes hard and brittle with age.

† Translator's Note.—The author uses "Malaise" and "Malaisienne" for Malay. Is it for the natives "Peninsule Malaisienne," and for the Europeans "Peninsule Malaise"? Probably, nay, certainly, tropical life is mostly *Malaise*-

As early as 1892, M. Jungfleisch proposed to extract the gutta from the dry leaves by means of an appropriate solvent. The author advises toluene, M. Rigole prefers carbon disulphide, and more recently M. Obach has proposed petroleum. By this method the trees are preserved and yield a great deal more.

The leaves may be first gathered from about the age of 10 years: from 10 to 40 years (maturity), the tree gives about 190 kilogrammes of leaves, yielding 9–10 per cent. of gutta, say 19 kilogrammes, or 60 times as much as would be obtained by felling a tree 30 years old. This new and successful process should now be tried on other species of gutta-producing trees.

M. Pierre recommends the propagation of *Palanquium Malaccense* which yields the *terbow-mera* gutta of the Malayan peninsula; *P. oblongifolium* (*Isonandra Gutta*, Hook. var *oblongifolia*, de Vries) introduced in the botanic garden at Buitenzorg, Java; several *Mimusops*, of which one, the *M. Balata*, yields the *balata* or gutta of British and Dutch Guyana; *Croixia Beccanaria* which in Borneo gives the *terbow-soutra* gutta. It would indeed be easy to apply Jungfleisch's process to any of the Sapotaceæ containing gutta.

All our tropical colonies produce trees of the kind. Réunion has some splendid Mimusops, *e.g. M. calophylloides*, H. Bn., and *M. Imbricaria* W., called respectively *Petite natti*, or *natti à petites feuilles*, and *Grande natti*, or *natti à grandis feuilles*. M. Jacob de Cordemoy says of them: "formerly very common from sea 'level up to 1,200 metres, these trees, being continually cut and 'never planted, are becoming scarce." Such plantations could almost certainly be made, for M. Bojer cites several species of *Mimusops*. *M. Elengi*, *hexandra*, *Kaukii*, *fruticosa*, &c., as being actually under cultivation in the public gardens and elsewhere in that climate. Every colony might find a different species suited it best, for Cochin China the genus Palanquium seems indicated. The colonies in the Indian Ocean will doubtless suit *Mimusops*; the *Vitellaria paradoxa* (*Butyrospermum Parkii*, Kotsch) grows spontaneously in Africa and gives a very good gutta called *Seriba*. In America the *Mimusops Balata* extends from northern Brazil to the Antilles, and in Brazil itself *Mimusops elata* furnishes a gutta called Maçandulia. It is possible that further enquiry may result in the discovery of other useful species. It is easy to foresee a further extension in the demand for gutta, since it is the best possible insulating medium in all electrical work. Not only in submarine and land cables, but in surgery, in domestic economy, in Public Works, and in a large number of arts and industries, gutta is of extreme importance. England alone, between 1845 and 1896, has consumed 48,000 tons of gutta, and still the demand increases.

The timber of these trees is excellent, being strong and heavy and well marked, they are in great demand not only for building

but for joinery, &c., and it is sure that in the near future, gutta trees will acquire a greatly increased importance.

F. JADIN,

(In the Révue des Cultures Coloniales and Révue agricole de l' ile Maurice.)

III.—OFFICIAL PAPERS & INTELLIGENCE.

On the Manufacture of Tannin Extracts in Burma.

Modus operandi, 1st day.

At 4 o'clock in the afternoon, a trench is half filled with fuel consisting of dry split bamboos and the splints obtained from the barking-shed. The chatties are then placed in position along the trench and half filled with *fresh water*; * then chips are forced with a rammer into each chatty to its utmost containing capacity. At sun-down, the fuel in the trench is lighted and allowed to burn throughout the night. Early next morning, the cauldron and evaporator are placed in position and fire lighted in the oven. This being done, the cutch decoction from the chatties along the trench is poured into the evaporator and other chatties which are placed near it. The chatties (along the trench) are then re-filled with fresh water, fuel in the trench renewed, lighted and allowed to burn till the re-filling of fresh chips commences, *i.e.*, 4 o'clock in the afternoon.

The decoction is poured from time to time into the evaporator according to its containing capacity; while the liquid from the evaporator, after it gets to about the consistency of treacle, is ladled into the cauldron from time to time. This feeding goes on till about 1 o'clock in the afternoon, when we find all the liquid in the cauldron, that is to say, since morning sufficient superfluous water has evaporated to allow of the whole filling into the cauldron. About two hours' boiling in the cauldron now is sufficient to drive off the remaining water in the form of steam, consequently at 3 o'clock in the afternoon, the cauldron is taken off the oven and the extract in it stirred with a wooden pestle, which helps to cool it, until it is perfectly cool and about to set, when it is forced in lumps into the mould.

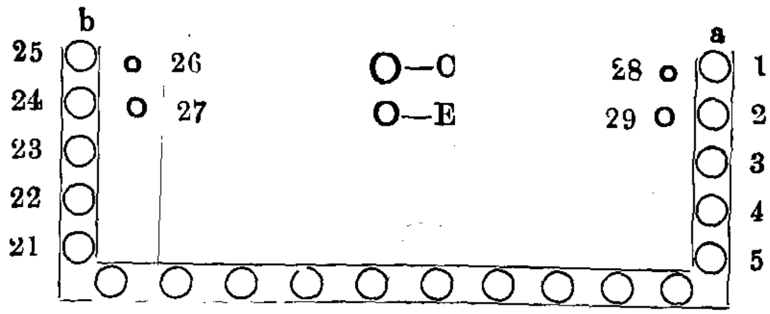
Modus operandi, second and subsequent days.

The emptying process.

At 4 o'clock in the afternoon, dry split bamboos are brought and placed along the trench on one side; the outer or the side

* Only on the first day is fresh water utilized in the afternoon.

remote from the cauldron. This being done, the emptying of the chatties begins. This operation is done best by two men, one at either end, as 'a' and 'b', *vide* sketch.



"A" takes chatty No. 1 and empties it into No. 28, leaving the two chatties thus :—

The chatties are balanced and won't fall, the chips won't drop out of chatty No. 1, because they have been tightly rammed. 'A' then takes No. 2 and empties similarly into No. 29, he then places two or three pieces of bamboo in the trench and returns to No. 1, emptying the chips from it into the trench to cover the space of two chatties, and then placing it in its original position in the trench. (Thus the chips from one chatty do as fuel for two for 12 hours, while the dry bamboos placed at the bottom help to ignite the moist chips.) 'A' next takes No. 3, and empties the liquid into No. 1, leaving it as before on No. 1 to allow all the liquid to drip out (the same as he did in the first instance with Nos. 1 and 28); he then empties the chips of No. 2, along the space originally occupied by the split bamboos outside the trench, to cover the same length of space as chatties 1 and 2. This being done, he places the chatty in its place on the trench. He then takes No. 4, emptying the liquid into, and leaving it resting on, No. 2; places dry split bamboos in the trench and empties the chips from No. 3 on them, next placing it (No. 3) into position on the trench. Then 'A' pours the liquid from No. 5 into No. 3, and and from No. 6 into No. 4, and so on, till he meets "B," who is emptying similarly from the opposite side.

Re-filling process.

Thus we have seen how the chatties are emptied and the fuel placed in position along the trench. There is nothing in the

chatties along the trench except a *cutch decoction.*—* (The fresh water that was poured into the chatties when the cauldron was placed in position in the morning, and allowed to boil steadily with the old chips during the day.) Next comes the filling of the chatties in the trench with fresh chips from the chipping shed. This operation is done best by three men, whom we will call *a*, *b*, and *c*,—'*a*' supplies '*b*' with a rammer about 4 feet long, and a bottomless chatty,—proceeds to fill the chips from one end of the trench into the chatties along the trench thus—he inverts his bottomless chatty till the mouth rests on, say on the mouth of No. 1 chatty.

He then allows '*a*' to pour the chips from the broken end at the top, while he rams them, standing, well into the bottom chatty with his rammer, '*b*' does the same with No. 2, and so on till the end.

C follows in '*b*'s wake, and with a small rammer, about 10 inches or a foot long, further rams the chips into the chatties till they are perfectly compact and tight inside. And so the fresh chips are put into the chatties. After all the chatties are filled with fresh chips, anyone of the three men, oftenest '*a*', brings water in a tin can and walks along one side of the trench observing the tops of the chatties; if water (cutch decoction) is visible through the interstices of the chips, it is all right; if not, the deficiency is made up with fresh water.

Lighting.

At sun-down the chips in the trench are lighted with a torch or burning cane carried on a tin tray with a bamboo handle, and allowed to burn throughout the night. Early next morning the cauldron and evaporator are placed in position, etc., etc., (same as for 1st day).

Feeding.

The cutch decoction is emptied from chatties along the trench into the evaporator and other chatties such as 26, 27, 28, and 29 in sketch, leaving nothing but chips left over from the previous evening. Then fresh water is poured into the trench chatties until water is visible through the interstices of the chips. Next, the chips that were placed along the

* Obviously fresh water has to be poured into the chatties on the first day.

trench on the outside on the previous evening, * are pushed into the trench and lighted, continuing to burn throughout the day till 4 o'clock, when the filling of the chatties with fresh chips from the chipping shed is commenced. The cauldron is fed from the evaporator, from which the liquid is ladled out from time to time as it gets to about the consistency of treacle, with half a cocoanut at the end of a bamboo stick.

Consumption of fuel.

The consumption of a day's 'cutch' fuel weighs 180 lbs.

If other fuel be used, of less heating power, the daily consumption would average about 300 lbs.

NOTES.—*Extracts of cutch and Pyinkado were prepared from the wood,* that is, everything below the cambium layer was utilized.

Extracts of Taukkyan. In and Than were prepared from the bark only of each cutch, Pyinkado, Taukkyan and In two tons of chips were experimented upon and the outturn is given below.

Thus 2 tons or 4,480 lbs. of chips would yield (4480 × F) extract.

Note. F=factor which, when multiplied by the quantity of chips, will give the outturn of extract.

Cutch (Acacia Catechu).

Daily consumption of chips = 396 lbs.

Experiments extended over 11·3 days.

Daily average outturn of extract from 24 chatties and 1 evaporator

$$= \frac{589 \cdot 22}{11 \cdot 3} \text{ or } 52 \cdot 14 \text{ lbs.}$$

Total outturn = 589·22 lbs.

Value of $F = \left\{ \frac{589 \cdot 22}{4480} \right\}$ or ·131522

Pyinkado (Xylia dolabriformis).

Total outturn = 274·89 lbs.

Daily consumption of chips = 364 lbs.

Experiments extended over 12·3 days.

Daily average outturn of extract from 25 chatties and 1 evaporator

$$= \left\{ \frac{274 \cdot 89}{12 \cdot 3} \right\} 22 \cdot 34 \text{ lbs.}$$

Value of $F = \left\{ \frac{274 \cdot 89}{4480} \right\}$ or ·061359

Taukkyan (Terminalia tomentosa).

Total outturn = 399·66 lbs.

Daily consumption of chips = 336 lbs.

Experiments extended over 13·3 days.

Daily average outturn of extract from 25 chatties and 1 evaporator

$$= \left\{ \frac{399 \cdot 66}{13 \cdot 3} \right\} \text{or } 30 \cdot 04 \text{ lbs.}$$

Value of $F = \left\{ \frac{399 \cdot 66}{4480} \right\}$ or ·089245

* *Morning.*—The chatties are filled with fresh chips once in the 24 hours, *i. e.*, at 4 o'clock in the afternoon. They are also in the same time filled only once with fresh water, *i.e.*, in the morning.

In (Dipterocarpus tuberculatus.)

Total outturn = 398·01 lbs.

Daily consumption of chips = 196 lbs.

Experiments extended over = 22·8 days.

Daily average outturn of extract from 25 chatties and 1 evaporator

$$= \left\{ \frac{398 \cdot 01}{22 \cdot 8} \right\} \text{or } 17 \cdot 45 \text{ lbs.}$$

Value of $F = \left\{ \frac{398 \cdot 01}{4480} \right\}$ or ·0888415

Than (Terminalia Oliveri.)

Total outturn = 49·8 lbs.

Daily consumption of chips = 336 lbs.

Experiments extended only over one day.

S. E. F. JENKINS,
Forest Ranger.

30th May, 1898.

VI.—EXTRACTS, NOTES AND QUERIES.

The Composition of Indian soils.

The Agricultural Ledger for 1898 contains in No. II a note by Dr. Leather, Agricultural Chemist to the Government of India, on the composition of Indian soils. The soils dealt with are divided into four main types, *i. e.*, the Indo-Gangetic and other alluvium, the black cotton soil or Regur, the red soils lying on the metamorphic rocks of Madras, and the laterite soils. These four types are said to occupy by far the greater part of the Indian cultivated area, and to possess more characteristic differences in appearance than any other minor classes of soil. Each of these types is described by means of samples, and a statement is attached showing the composition of different samples of each type collected from different districts. The latter part of the

note deals separately with Coffee and Tea Garden soils, and also gives the results of the analysis of samples of the Poona, Nagpur, Cawnpore and Dumraon Farms' soils.

The conclusions drawn from the examination of the different classes of soils are briefly as follows. The proportion of Silicates is generally low or variable, except in the soils of the alluvial plains, where the amount is much the same as in English loams or clays. Judged from a European standard also, the proportion of Iron, Aluminium, Manganese, Lime, Magnesia and Potash appears to be generally sufficient or high. As regards Phosphoric acid, it is stated that the amount is frequently small, wherein the writer's results differ from those obtained by Dr. Voelcker.

Sulphates are contained in very small amounts, and the amount of organic matter is also generally small, though to this there are of course exceptions. The percentage of Nitrogen is usually low, and Dr. Voelcker's opinion that Indian soils are generally very deficient in Nitrogen, is amply supported by the results of Dr. Leather's analysis. Professor Wallace's opinion was that the fertility of the soil is not being exhausted by the native practices that have been going on for thousands of years in India, but then he makes a distinction between temporary and natural fertility, a distinction which Dr. Leather points out is not a real one, but merely a question of terms. The latter, however, thinks that the export of food grain from India has been considered to be a far more serious drain than it really is, and that it is more important to consider how the fertility of the land can be increased, than to consider whether the land is becoming exhausted, and that it would be more correct to say the fertility of the land in India is not only low compared with that of other countries, but that if it is not decreasing, it is certainly not increasing. He further states, also, that it must be admitted that with a better supply of manure the fertility would be immediately increased, and more grain produced per acre.

A big Deodar log.

During the work of preparation of sleepers in the Dumrali Block of the Deota Range, Jaunsar Division, an old deodar log was discovered buried in the ground. It was dug out and proved to be perfectly sound. When cut up, it gave 460 metre-guage sleepers and some 'kurries.' The base section, where a stump piece had been left, showed 534 annual rings,—all heart-wood—the sap-wood would probably have given about another 16, so that its age may be set down as 550 years up to the time of its fall. But since then a long period had elapsed, for a 6 ft. birch tree was growing on top of its roots, itself probably nearly 100 years old. There cannot, therefore, be much less than

650 years since the tree was a seedling. The length was about 90 feet—14 sleeper lengths were cut off it—and the mean diameter at the base was 7 feet. The bottom length gave 45 sleepers.

In the adjoining forest of Moriru, containing very large timber, but still showing marks of previous cultivation, was the base shell of a huge deodar, 34 feet in girth, and near by was another, 7 feet in diameter, growing on top of a rough masonry wall, which had probably belonged to a house or temple. On a rough estimate, nearly 700 years must have passed since the house became a ruin.

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Method in Fire Conservancy.

My apology for writing on such a hackneyed subject as Fire Conservancy is, that since there are various systems in different parts of India, a comparison may be advantageous, and also, because I wish to elicit from other foresters ideas on the subject that are new and will be of use to myself. I think one is a little too apt to trust to luck in Fire Conservancy, and as soon as the monsoon has removed our anxieties, to forget the lessons of the past months, and put the painful subject aside. So that, perhaps, there is room for more method in carrying through this, the most important of all an Indian Forest Officer's duties. As long, moreover, as we are careful to mention that we are only theorizing (and not stating things proved by experience), I believe much good may arise from airing new ideas. For while there may be much that is wild in many of them, they may, nevertheless, suggest useful innovations, or, after modification and paring down to fit them to hard fact, may result in something practical. Thus, Mr. Fernandez suggested that we might adopt the plan of a telephone, as used in the south of France, and, though it probably sounded extravagant to many, circumstances are imaginable in which it might conceivably pay, and the telephone be utilized, not merely for Fire Conservancy purposes, but to replace (under suitable safeguards) much of the lengthy writing and carrying of "dâk" by rapid verbal communication with Range Officers.

Fire-protection, as I have seen it carried out, has consisted generally in the clearing (at great cost and some risk) of fire-lines, the appointment of fire-watchers, and—when a fire occurs—in the calling out to extinguish it of such persons as the Forest Act gives us a claim upon.

The burning of fire-lines not unfrequently results in the burning of the forest itself, and the area put out of cultivation by making fire-lines is considerable. Of the former, most people

will be able to recollect examples. As an example of the latter, I calculate that in the last Division I held, there were something under 3 square miles of fire-line to something under 300 square miles of forest protected, and the system of lines was not as yet complete. One per cent. may not seem high, but three square miles of forest is not inconsiderable. Thus, if fire-lines could be reduced it would, in some senses, be economical.

At the same time it is a mistake to be parsimonious in spending money on such an utterly important measure as Fire Conservancy, and I would unhesitatingly spend far more than at present, did it result in increased efficiency. Only it seems to me that money might sometimes be better applied to this end of efficiency in other ways, while we could, without impairing efficiency, save in some directions in which we now spend. We will consider this below.

Then I think the present method of employing fire-watchers may probably be modified with advantage, and the services of many of them be better utilized in another way. The fire-watcher, all unwatched in the forest, is sometimes a risk himself. This point, too, we will consider below.

As to the calling out of right-holders, and the others similarly placed in this connection, what labour it generally is! How long they take in coming, while the fire is increasing by arithmetical progression, and how they melt away at the first possible moment! Their work is often quite unskilled, and they put no heart into it at all. Finally, in distant parts, it sometimes happens that no such help even is available. The cases of willing help are few and far between. These persons must, indeed, be called out, but to rely on them for practically all the work in putting out fires is, in my opinion, quite an insufficient precaution to take. The forest establishment and fire-watchers are spread over large areas, and only the few within reasonable distance can come. In fires extinguished by means of right-holders, *very* much larger areas are burnt than would be the case with more efficient men—and inasmuch as there is in this way a great loss of prospective revenue to the State, it is the reverse of true economy to trust to these persons alone. Had we a more complete system, I believe we might annually save a great deal that is at present burnt.

Everything (including experience) points to the high advisability of *maintaining regular, trained, expert gangs of firemen*, men whose special business it is to extinguish fires. The direct expense is, no doubt, considerable, but the indirect economy is very great. Even the direct increase in expenditure does not amount to much more than the difference between the employment of daily labour and of contract, as we shall see further on. There is a great deal in habit, and one will sometimes see an officer extravagant about, say, plantation, which

is a time-honored forest operation, while yet he will think twice about spending money on some useful measure of Fire Conservancy. But are not Rs. 5,000 (or even Rs. 10,000) better spent on fire-protecting 200 sq. miles of forest than Rs. 500 on 20 acres of plantation?

Moreover, it seems to me probable that in the future Fire Conservancy will be more difficult than at present. Fires due to mere ignorance have already much decreased, and will continue to do so, but the population will more and more press up to the reserve boundaries, and the fear of that vague power, the *Sirkar*, which now in distant parts acts strongly through its very mysteriousness, will probably pass away, and the ease with which fires can be lit undetected, will be discovered sooner or later. Then rapid and expert dealing with fires will be absolutely necessary.

I have myself worked with fire-gangs for some years in more than one Division, and I believe it is a long-established practice in the School Circle. My original reason for adopting it was that my forests were so placed that I ran the risk, unless I made arrangements in advance, of finding them on fire and no one available to put them out. Moreover, it was so strongly borne in upon me how exceedingly important it is to tackle fires at an early stage, and how rapidly a fire, at the beginning quite manageable, may run into a dangerous conflagration, very difficult to extinguish, and burn an enormous area. But the same reason that led to the necessity for making arrangements in advance, also made it no easy matter to raise the gangs, and to organize the system as satisfactorily as I should have liked. Labour was very hard to obtain, by reason of the unhealthiness of the place. Nevertheless, I had progressed very fairly well, and had I remained in that country, I am convinced I should have been able to carry the thing through completely. I do not know if the plan has been carried on since I left. I note all this, as it is very important to remember that the universal "*dastur*" *of India takes a considerable time to conquer*, until in its turn, a new "dastur" has been established. Much steady pressure and perseverance are requisite to thoroughly inaugurate systems of this kind, and until this has been patiently done, the thing must not be considered to have had a proper trial. It was the same, I am told, when Fire Conservancy was first started in the "Bhabar" Division of the Central Circle (N.-W. P.); fire-watchers were very difficult to get, whereas now the post is much run after. I found much relief from having these gangs, and their presence resulted in greatly curtailing the area which would otherwise have been burnt.

It will be well to quote a few examples of the great use that fire-gangs have been in places where they have been employed.

The most marked example I know is that of the Ranikhet Reserve in the Central Circle of the N.-W. P. This Reserve consists of Chir (*Pinus longifolia*), than which it is hard to find any class of forest more inflammable. The habit of the species is to grow, after a certain age, in a relatively open condition, thus encouraging the growth of grass, and enormous quantities of resinous needles drop steadily throughout the hot weather. Moreover, it grows on slopes, up which fire rushes, and down which also it spreads rapidly through the rolling of flaming cones and dead wood. Then, the Ranikhet Reserve is placed most awkwardly and dangerously, for it adjoins a Military Station, and soldiers, who smoke continuously, are constantly in it. The soldiers are generally ignorant of the meaning of Fire Conservancy, very often do not understand the warnings of the establishment, and, it is to be feared, pay little heed to them when they do understand. Such a forest would, one would think, be burnt through and through constantly. Yet since the beginning of fire-protection in 1877, there has only, I believe, been one serious fire. That fire got completely out of hand, burnt the whole Reserve, all the neighbouring forests, and, I think, pretty well the whole station area, endangering the buildings themselves. The reason for this comparative immunity is simply that the Chaubattia Forest garden overlooks the Reserve. At this garden is the Ranger's head-quarters, and some thirty men work there practically always. The moment smoke is seen, the Ranger and this gang pounce down on the fire and prevent its spreading. Annually, some eight or ten fires start, but they are promptly extinguished. Such is the advantage of having a gang ready to the Ranger's hand.

Another example is the case of the Airadeo Forest, in the same Division. It consists of some 16,000 acres of Chir, and was some years ago much afflicted by bad incendiarism. One year half the forest was burnt in about a week, the incendiarism only beginning about a week before the Rains. The next year a gang (of some twenty or twenty-five men, if I recollect rightly,) was employed, ostensibly to make roads, but really of course to guard against fires. There were twenty-three fires lit that season, fourteen of them being lighted in one night! Yet only some 2,300 acres were burnt—the comparative immunity being entirely due to the presence of the gang.

Some three or four years ago there was an extremely dry season, and the Fire Conservancy returns of the province (N.-W. P. and Oudh) presented a truly pitiable spectacle. Tens of thousands of acres were, if I recollect rightly, not seldom burnt at a time, and it was the rule for the fires to be very large. But the record of the Dehra Dun Division of the School Circle, although it showed a considerable number of fires, also showed that in all cases, save one (which, however, was, I think, under 2,000 acres), the fires had been quickly ex-

tinguished. That one relatively large fire came over from the neighbouring Division, and was in distant and difficult country. I believe I am right in saying that it is the custom to entertain fire gangs in the Dehra Dun Division, and to these gangs the early mastery of the fires was in all probability due.

It was remarked above that if we could reduce the number of fire-lines, we should economise both area and expenditure, and avoid risk. A regular trained gang will of course burn lines far more safely and expeditiously than a scratch gang collected temporarily for the purpose, and this is in itself a strong argument for entertaining a gang of expert men. But the wind may spring up suddenly during line-burning, any accident may carry the fire from the line into the forest, and therefore, *primâ facie*, the less line-burning we have to undertake the better. Now I maintain that *men (on the spot) are worth more than lines.* An examination of the fire-record maps will generally show that the greater part of the perimeter of burnt areas, if not the whole, lies in the forest itself, or along some little stream or path. The lines are usually fallen back upon only as a last resource. And with an expert gang this would be still more the case. As the system, then, is more and more thoroughly organized, I hope for the gradual reduction in the number (or at least the area) of fire-lines, which are now becoming very numerous and unwieldy, and a great tax on our time and money. As for the work of the gangs, I believe it will improve continually, until a splendid pitch of efficiency is reached.

It may be that the form of fire-line we shall eventually be able to do with—at least in large proportion—will be one merely suited for counter-firing from. Such lines need not of course be so broad as lines intended to act automatically, a thing, moreover, that even very broad lines will often fail to accomplish. As long, however, as we cannot be sure of having men, and those skilful, on the spot, before the fire has attained large dimensions, this increase in the relative number of small to large lines might be unwise. Even if we could rely on the early arrival of impressed men, we could not rely on their skill, energy and care. Too much stress can hardly be laid on the *great* advantage of having men ready to hand who are experienced in choosing the right place for, and the right method of, attacking a fire, who will in consequence be bold and enterprising, and who will exercise that great care both in working forward and patrolling back, that is so necessary to prevent the recrudescence of a fire, and for the want of which so many fires break out afresh.

Special arrangements for the efficiency of the gangs should be made in various ways. In the first place, grumb-

ling or idle coolies should be eliminated carefully, and the mates (*i.e.* head-men) should be chosen with circumspection. Often it is best to let the mate bring his own gang, only insisting on the removal of unsuitable men, and seeing that as far as possible, the same men are brought each season.

It may even be wise to pay slightly higher wages to specially good men. We shall thus obtain a gang that will work well together, form a sort of family party, and be much more contented than it would otherwise be. A great thing is to try and establish the notion that this particular service is the special property of this particular gang, and care should be taken not to lightly change the mates or unnecessarily move the gangs to ranges they do not know, for habit goes for so much with them. Each man should have a sickle (*daranti*), a few of them axes also, while one man of high caste should be water-giver for fires to the whole party. Each man should carry food with him when he goes to work, that an immediate start may be made if fire breaks out. Each range, too, should have a proper supply of empty kerosine tins, or *mashaks* for extinguishing burning stumps. And in this connection I may mention that when a Range Officer turns out villagers or others to go to a large fire, he will do far better work by stopping to see that every one has food with him, that suitable men, properly provided with vessels, are appointed to supply drinking water, and that sickles, axes, kerosine tins or *mashaks*, &c., are taken, than by rushing off any how to the fire, and allowing the men to come straggling along, unequipped, to the fire, before reaching which, moreover, they will, if left to themselves, have considerably dwindled in numbers. A little "*bandobast*" will go very much farther than a deal of hustling about. When food has to be sent up to a fire, a good form to supply is "*sattu*," a sort of ready-prepared cake.

Now, although efficiency will mean economy in extinguishing fires, the fire-gang should not be allowed to simply sit still and wait for fires. It should be employed on works which can be done during the hot weather in the comparatively cool hours of the morning and evening. Some six or seven hours' work can in this way be accomplished. The following are works of this kind. Climber-cutting in coupes and along lines and roads (to prevent the leaves of the climbers blowing on to them), girdling trees to be killed on new fire-lines, or under the prescriptions of Working Plans in worked out coupes, removing rubbish from fire-lines, or dead wood from near lines, roughly repairing main roads still open to export, valuation surveys, watering in plantations, and many other works which do not involve great bodily labour or digging in hard ground. I might add tree-marking in coupes, but of course the selection of trees is better done while the leaves

are on, which is not the case in most of the N.-W. P. forests during the hot weather. Nevertheless, so great are the areas to be now marked under the new Working Plans, that it is seldom possible to finish the marking during the cold season; moreover, the state of the grass in the hot weather allows this work to be more easily done during the hot than the cold weather.

In some parts it is very difficult to obtain labour during the hot weather, and it is then necessary to pay the men a rupee a month more after the 15th March (or possibly the 1st April). It is also necessary to withhold this rupee until the gang is dismissed, and only to pay, provided the man has stayed right through to the end. Absolute strictness on this point must be adhered to, for otherwise the men will leave on all sorts of excuses. Even the excuse of illness should not be accepted, for although it seems hard, who can always correctly judge of what is really illness, and after all, we do not want sickly men to serve in the gangs. It should work quite automatically; the man who has stayed right through is the recipient of the extra pay, the man who has not done so, is not. Only if an equally efficient substitute has been provided by the man, can this rule be perhaps relaxed. All the rules and conditions of the service should be set down clearly on paper and signed by each man, so that he may know what to expect, have no cause for complaint, and feel himself bound. In order to make the service more acceptable, the Range Officer should be most careful to disburse the past month's pay *regularly* on the morning of the 7th of the following month, thus holding in hand one week's pay in addition to the deferred pay referred to above. This regularity goes a long way with coolies. But Range Officers are sometimes very bad about attending to this rule.

I do not know if it would be wise, or not, to go a step further and give small rewards for the specially successful fire-protection in specially difficult places. As an example, suppose in one range we have a gang of one mate and 12 men, who, by extra good service, have prevented the area burnt, from exceeding 100 acres. Perhaps we pay the mate Rs. 5, and each man Rs. 2; total Rs. 41. In another range with less success (say not more than 300 acres burnt), but still good service, we award perhaps Rs. 2 to the mate and Re. 1 to each man; total Rs. 14. There may be drawbacks to this plan, but if emulation towards success is induced, it will be a great thing.

I think the entertainment of a special gang will allow us to reduce the number of the fire-watchers a little. These men should be posted at a few points, so selected as to have the whole fire-protected area observed, or they should be specially appointed to patrol open roads, or places where trespass is probable. It

seems to me they are at present sometimes uselessly employed to walk along quite unfrequented lines, and might there be done away with. It should generally be possible, too, to have the whole area observed from a very few high points.

As explained above, the gang would be employed on works suited to the hot weather, but there are other works only possible in the cold weather, for which specially trained men would be very useful. Such works are tree-felling, road-making, fire-line burning, and some others. In close pole forest, worked under Improvement Fellings, it is really impossible to allow the purchaser to fell himself, for he is careless, and no amount of fining will prevent great damage being done. I should be inclined, also, to do the fire-line work with a regular expert gang, for such men will, by reason of their training, work quickly and also safely. Thus, it may be worth while to sometimes employ special gangs during the cold weather also, and doing so would save us from many, often irretrievable, mistakes. But of course there is not as much ground for entertaining special daily labour gangs in the cold weather as in the hot.

In large fires, extraneous assistance will, no doubt, be required, and it will be necessary to call out those upon whom the Act gives us a claim. Indeed, it is useful sometimes to do this, lest these persons should forget we had a right to their services, but too much of it is very harassing. We should be careful, too, to insist on our call being obeyed, and punish recalcitrancy promptly; otherwise people will systematically refuse to come. It is, however, often very difficult to prove that the summons was actually delivered, and it is, therefore, very necessary to make methodical arrangements, so as to prevent escape by means of an excuse of this kind. Before going further, I would draw the attention of officers to a peculiarity of the Forest Act. The section under which we can call out assistance has no penalty clause, and although there is another section prescribing a penalty for a breach of *Rules* made under the Act for which no special punishment is given, this will not suffice. I believe, however, that a punishment can be inflicted under the Penal Code; but officers who are Magistrates under the Forest Act have no power, it seems to me, to punish. The calling out is, I think, best done through the District officials (tehsildars, patwaris, &c.), and the Forest Officer will do well to ask the District Officer in advance, to impress upon his subordinates, possibly even at the beginning of *each* hot weather, the necessity for assisting in putting out fires. Ignorance of the Forest Act is very common in this matter. Another plan which may be useful, when the first is not feasible, is to supply Range Officers with printed forms of demand for assistance, the section of the Act authorizing the demand being printed *verbatim* on the back of the form. Vacant spaces for the name of the head-men summoned to call out their villagers, and for the names

of the *two* persons (for to send *two* is desirable) who may carry the summons, should be left, and filled in at the time by the Range Officer, who will of course then sign it.

It is very important, indeed, that the countryside should realize the fact that there are not two *Sirkars*, but one *Sirkar*, and that the District Officer is behind the Forest Officer. The former is, in fact "the man with the stick," and this is an aspect of him well understood by the people. The District Officer is, in many cases, to some extent the official superior of the Forest Officer, and this is often of great use. But it is well for the latter, in his own interests, were there no other good reasons, not to be too departmental-minded. An imperial-minded attitude on the part of the Forest Officer will lead the District Officer to look at forest matters in a more sympathetic way, and that is the only true position in which to judge rightly of anything. The District Officer will then no longer merely admit *theoretically* the advantage of Fire Conservancy, but he will discover its extreme importance. Once he has progressed this far, an immense step has been made. Indeed, in view of the coming increased difficulty of Fire Protection, it is all-important to secure the adherence of the District Officer, not to speak of its other great advantages Then we shall see him regularly doing things such as I have once known a District Officer do (and that not in the presence, or with the knowledge of the Forest Officer), *viz*., call together the people where an incendiary fire had occurred the previous season, and give them a severe rowing for burning, as he said, "*my* forest."

These are forcible measures, which are unfortunately often necessary, but it is of course much better to *lead* the population, when practicable, to help in Fire Conservancy. Splendid work in this direction has been occasionally done by some officers, and it is to be hoped their methods may spread. Whenever it is possible to employ *local* labour on forest works, it should be done. The population should (and would, were it less ignorant) look upon the local forest as its "father and mother," a fruitful source, ever ready at hand, to supply them with the means of paying the land revenue demand. There are a few cases in which distant villages are administered by the Forest Officer, and I believe the plan acts well. The villager is there "the man" of the Forest Department, and I dare say he objects to forest measures, that is, really minds them, much less than he would under the ordinary circumstances, while probably the Forest Officer, too, learns to see better where the shoe really pinches, and unconsciously maintains a more sympathetic attitude. Much depends on the character of the Range Officer. I have known one, much beloved, and looked up to in the countryside. He could always obtain labour and protect his forests well. On one occasion a fire occurred accidentally

in this man's Range, and two hundred and fifty men immediately left the collection of their crops, and, without being called, came and put out the fire; nor would they accept any payment. I am glad to say it was possible, later on, to repay them by granting fire wood to rebuild their village, when it was burnt down. Probably this Range Officer's method consisted merely in good-tempered tact and prompt payment for work done. He was not even a high caste man, though care should always be taken, if possible, to have high caste Range Officers. It is a point much too seldom remembered.

Although local labour should always be employed when practicable, it is not, I think, wise to appoint local fire-watchers. They can often obtain more help in case of a fire than an outsider can, but so many of them have enemies, and what more easy and obvious than to try and get the fire-watcher into trouble by lighting his forest. For a similar reason it is usually unwise to contract, as has sometimes been done, with local head-men for the protection of an area of forest.

While a reduction in the area occupied by the larger class of fire-lines is much to be desired, a certain number will always no doubt be a necessity, and it may, therefore, be useful to note a few points connected with their effective making and up-keep, for systems vary. I have served in a Circle where they make so-called "*kutcha*" lines, that is, lines not cleared of tree-growth, and also in another Circle where so-called "*pucca*," that is, completely cleared lines, are the only kind used. I am unhesitatingly in favour of the latter, where it is a question of forest of which the leaves drop in the hot weather. Thick belts of tree-growth killing out grass can be made much use of during a fire, but for a line proper, this is not sufficient, nor will *kutcha* lines often grow like this I suspect. Although clearing tree-growth puts much ground out of cultivation, the trees on *kutcha* lines will not be growing under favourable conditions either. It seems to me that *kutcha* lines cannot be effective. They remain damp (and therefore unburnable) as long as the surrounding forest, and, in Sâl forest anyhow, become constantly covered with dry leaves. To be continually sweeping these lines involves much labour and industry, and any dereliction of duty may render the line useless at any moment. With a *pucca* line, on the other hand, we have the grass drying much earlier, so that it can be burnt while the forest is still damp. Mr. Fernandez says such lines become covered with dry leaves like *kutcha* lines. If it were so, it would, at any rate, not involve the same amount of sweeping, but I cannot agree that it is so. Some leaves, no doubt, blow on to the line, but even these few can be reduced by care in having all climbers cut along the edges, and by cutting back the branches of the bordering trees. The leaves of the *maljhan* (Bauhinia Vahlii) fall thickly, and are a source of danger if not so dealt with. The

cutting back of branches will induce a bushy growth, and also bring up a close crop of young trees along the line edges, and thus, in Sâl forest, form a thick wall of young green leaves early in the hot weather (since young Sâl comes quickly into new leaf), which is a safeguard against flying sparks. The thick young growth, too, will kill down the grass along the edges, and facilitate line-burning. On the *pucca* lines, the grass, besides drying early, will grow well, and this results in a more thoroughly-burnt line. In one Division I held, I found 40 ft. lines in Chir forest. This width certainly was insufficient to keep clear of needles, but I broadened the lines to 100 ft. and I am told by the officer now holding the Division that the width has been found sufficient for the purpose.

Another difference of system between the two Circles abovementioned is, that while in the one the standing grass is burnt from cut guide-lines, in the other they cut the whole width of the lines, leave the cut grass to dry, and then burn it. The latter plan is about ten times as expensive as the former, and depends on a large labour-supply, because full-breadth cutting is a long process. But it is much safer, because it allows of the lines being very cleanly burnt early in the year, while the forest is still green. It seems to me that a compromise between the two systems is the right course, but it will take some time and perseverance to introduce, where full-breadth cutting has been in vogue, since the contractors and Range Officers are both against it. Less money passes, and the old system has become a fixed "*dastur.*" Officers should realise how difficulties are manufactured on such occasions, and that steady purpose must be brought to bear before such measures can be considered to have had a fair trial. I have myself given the plan a short trial, and succeeded fairly well, and I can see that a little more steady pressure will bring it through to complete success. My rule has been to have only guide-lines cut, except in dangerously steep or damp places (where the full breadth was cut). The grass from the guide-lines is of course thrown on to the edge of the grass that is to be burnt. The first burning should be made in December or January, before the winter rains, so far as this is practicable, and during the hottest part of the day. This burning will be incomplete, but what remains to be done is short and simple. The men must return along the line, cutting the unburnt parts, and a little later on, after this cut grass has dried, it can be quickly and easily burnt by a few men. We shall thus have made what use we can of fire, and, at a considerably reduced cost, have cleared the lines cleanly while the forest is still green, and got our lines ready well in advance of the dangerous season. Ridge lines, being the best drained, dry earliest, and therefore, should be the first to be taken in hand.

It is of the greatest importance to clear away rubbish from upon, and from near, lines. Bamboo-cutters and dry wood exporters have a bad way of preparing and chopping their produce

on lines, leaving much refuse. This refuse takes several years to burn away completely, or disappear through the agency of white ants, and cannot be safely left where it lies. Then when cutting new lines, the contractors must of course convert the timber on the line, and they fail to properly collect the branches and chips into heaps along the centre. Sometimes I have attempted to make them drag all inexploitable material into the forest to a distance from the line, but this is difficult to enforce, and not a good plan in several ways. Very large logs, that for any reason are not exploitable, are a source of difficulty, and if left, take many years to burn, and remain a source of great danger. I really think a few dynamite cartridges would be the best way of breaking them up.

When there is young growth on new lines to be cleared that will coppice up again if cut, it should be girdled instead of cut, or, if very small, grubbed up by the roots. The following year it can then be cleared, and this should on no account be postponed, for girdled trees which are left standing on a line are of course terribly dangerous. I have known girdled lines from which the trees have not been afterwards cleared ; there was a constant fall of dry wood and bark, which covered the line with smouldering refuse. In the same way stumps will smoulder for weeks, and the fire, being inside, may not at once show. Theoretically, one might cut the stumps very low, with a saw for choice, and peel away any bark that remained, but practically, though expensive, I think grubbing up by the roots is preferable. This, however, is impossible with enormous *Bargat* (Banyan) and such-like trees.

Our Working Plans often prescribe the girdling of trees which, though marked for removal, have not been found worth removing by the exporters. Such trees should not be girdled within, say, 300 ft. of a line. In fact all dry wood is best removed from near lines, and if it cannot be sold for fuel or charcoal, it may be *given away* free. I have often got lines, burdened with trees, very satisfactorily cleared by giving the material away at a low rate, or free, to charcoal-burners. All the dead stuff (and the green too, that requires removal) within a given distance of the line can be given in also.

There is difference of opinion also on the subject of fire-lines along ridges. I have known two neighbouring Divisions, separated by a rough ridge having no line along it. This boundary ridge was in very scanty, dry forest, very distantly situated. The anxiety this used to cause was very great, and it was fully justified, since fires constantly crossed and caused great devastation. The question of a ridge-line was mooted, but was vetoed, I believe, on the ground of the rough nature of the ridge and of expense. The saving that might have been already made by stopping the bad fires that have crossed, would have made the expense to be incurred worth while, and as to the roughness of the ridge, the

neighbouring circle contains great lengths of ridge-line in extremely rough ground. By cutting the full width of the grass in bad places, these lines are safely burnt; indeed it is quite extraordinary in what difficult places they can be burnt in this way, early in the year Nevertheless, where a ridge is exceptionally bad, a little ingenuity will often allow us to get round the obstruction;—one can perhaps leave the ridge, run down a spur into a stream, then down the stream, and up another spur. This will avoid running the line along a side-slope, across which burning material could roll. Still, although this is only an idea which I have never actually tried, I belive one might, in order to avoid a bad bit of serrated ridge, run the line safely across a side-slope by banking up its edge (for choice its lower edge), so as to catch rolling fir-cones and so forth, but the bank would have to be somewhat steep and high, since burning fire-cones will bound. If, then, in the case of the ridge I mentioned above, some such plan were adopted in dealing with the bad places, and a line made the whole length of the ridge, my belief is, that a very useful and important work would be the result. The place is one where even a permanent gang could not be located, and where, by reason of its exceptional difficulty, they would need a broad line to work from. Personally, I would go further and make the line so broad that it would act automatically, for the forest is very poor, and never will be otherwise.

Much economy can be effected by carefuly examining the map, and utilizing broad stream beds as much as possible. A short length of line across a ridge between two stream beds will give very effective protection, and require very little annual clearance. If the grass encroaches on one of these stream beds, it should of course be burnt off.

Evergreen belts are sometimes spoken of for fire-lines, and it has been suggested to plant *Ficus elastica* cuttings for this purpose. I am not in a position to judge of these suggestions, but I have often seen the value, when extinguishing fires, of thickly-grown advance-growth which has killed down the grass. It is in such places very quick and easy work to clear a small line among the leaves to counter-fire from, and when such growth is in the form of a belt, it makes a very useful form of fire-line, not, of course, an automatic one, but one which can be utilised when men are on the spot. And this is a strong argument for growing our forests, when the species will admit of it, on the uniform system (shelterwood compartment system of Schlich), which, fully brought into shape, will give us a forest without grass, save over an insignificant proportion of the area. This result cannot be hoped for, I suspect, from the selection system.

Mr. Fernandez's rule for the width of guide-lines (*vide* his "Rough draft of Indian Sylviculture") is that they should be made equal to the height of the grass to be burned, plus

three feet. This seems sound, but should be held to be only a general rule. In the Ranikhet Forest, they burn the lines in November without any gude-lines at all, and in Oudh they used formerly (I do not know if it is so now) to burn off the grass-lands direct from the edge of the forest without guide-lines, relying on the grass being thinner and damper under the trees than in the open. But such a procedure would often be quite impracticable. Again, it sometimes happens that the Range Officer and his scratch gang are not very clever at fire work, and cannot safely be allowed to burn off grass-lands from anything but broad guide-lines. An expert gang would be able to save both time and money in this matter.

Range Officers are apt to put off burning the grass-lands till late, so that they may burn cleanly, but this involves great risk to the forest, and I consider the best method will be to start the burning early, and let the fire do what it can, and then send the men back along the forest's edge, cutting, for some given breadth, all the unburnt grass, and burning it a few days later when dry. This will give us a protective line, made early in the season, and allow us to await the complete drying of the grass-lands before firing them finally.

In cutting guide-lines along the side of grass-lands, one is sometimes tempted to try and lead the forest to extend outwards into the open by leaving an edging of grass for the seed to fall into. But apart from the fact that the forest has probably not grown there for some good reason (as, for example, want of drainage), the gain is not worth the risk involved, and is the reverse of economical, since by clearing the guide-lines under the outer fringe of trees, we have much less grass to cut, and there is much less danger of the forest catching fire when the outer grass is being fired.

It is preferable in hilly country to have the outer line of the protected area along a ravine rather than a ridge, because it is always likely to be windy on a ridge, and therefore, risky when burning off the outer forest. The grass remains green longer in a ravine, but on the other hand, the fire will travel well up the slope when once started, and so the outer forest will be cleanly burnt off. Range Officers always try to wait as long as possible before burning the outer forest, so as to get rid of as many of the dead leaves as possible and burn cleanly. They are thereafter less harassed by alarms of fires approaching from the outer forest. The reasoning is sound, but it entails much risk, and obliges us to have an outer line of fair breadth, cleared at the same time as the internal lines, and prevents our merely burning the outer forest from a guide-line.

Lines are sometimes cleared along roads, although there may be a broad river alongside. If such a road is only open

to forest traffic, one ought to be able to so regulate the traffic as to avoid the necessity for a line, but when the road is a public right of way, the line may be unavoidable. With only forest traffic a strict enforcement of a few rules, such as are given below, should meet all requirements. If a fire occurs through non-compliance with these rules, the traffic should be rigidly stopped, either at once, or at some earlier date than was originally intended. No traffic should go on during the night, or if so, only in batches of carts or carrying animals accompanied by a fire-watcher, for while the rules are readily obeyed during the day, smoking will often be indulged in along the roads by night, when the exporters feel they will not be caught. Camping, cooking and smoking should only be permitted at large, cleared, camping-grounds. Since these *camping-grounds get very quickly* covered with cow-dung, *bhabar* grass, and all sorts of rubbish, they should be surrounded by an outer cleared zone, whereon no camping at all should be allowed. No grass, or otherwise inflammable huts, should be allowed within 300 feet of any fire-protected area. This broad distance is necessary, because of the sudden, strong sand or wind-storms that so often occur during the hot weather. It is almost inconceivable how callous people of all kinds, not omitting forest officials, are in this matter. Yet it is an *absolutely* essential point, and the rule should be maintained *with great vigour. All grass sheds should be thrown* down near any route which people may possibly take, as soon as the fire season begins.

Occasionally we have public roads passing through forests, along which large numbers of people, perfectly ignorant of fire-protection (as for example, pilgrims), travel in great numbers. In such a case it is often practically impossible to make all these people adhere rigidly to Fire-Conservancy rules, which, moreover, may lead to great friction, and even the firing of the forest in revenge. The only thing to do is to isolate *the road by lines drawn well back, and sacrifice a strip of* forest on either side of the road, burning it off, and permitting fires and smoking.

The question of whether or not to allow export of forest produce during the fire season, is an important one. I do not believe in stopping it rigidly throughout the forest, for it means that exporters will have far less time to remove their produce, and will therefore, either not buy at all, or only buy a little. The longer the working-season, the greater will be the revenue. All the large main routes should be left open, *in my opinion, and efficiently patrolled to enforce the* rules above given. Then the purchasers will arrange to do all their carriage from the forest to the main routes during the early part of the season, and the carriage along the main routes later on. In practice the rules are well obeyed, and

the men who work at export become thoroughly accustomed to them, and know what is expected of them. If a fire does occur somewhere in the forest, all these men are at hand to help.

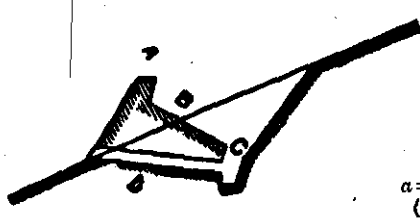
In some places there is a rule that a path of about 4 ft. should be made along every fire-line and repaired every year. This sounds theoretically very correct, but in practice it is wrong to make a hard-and-fast rule. The cost of these paths, with their repairs, mounts up to a vast sum, and is an annual and increasing burden. In the plains and easy hills perhaps, the paths should be so made that a pony can be ridden along them, and even then—on the flat at least—two feet gives enough room, but where the ground is such that a pony could not in any case be ridden, the nearest tracks will meet all purposes and will suffice for a pony to be led along, or for men to pass. It may often be well *to cut a good path to start with, but* thereafter it will be an unnecessary expense to fully repair it annually. All that is required is to see that it does not get choked and that slips are mended. The roots of grass should not in such cases be dug up. One often sees old paths in the forest, that have been abandoned for years, which one can still make use of, the roadway having got set and fixed firmly by the grass roots. This is one of the directions in which I would save money under Fire Conservancy, while spending it with no stinting hand on the up-keep of Fire Gangs.

There is a great deal of work for an active officer in looking into the details of Fire Conservancy. A little stupidity on the part of Range Officers in the choice of look-out stations, may mean that a fire has become large before it is discovered, while on the other hand, a carefully-chosen look-out station may do away with the necessity for several others. The *Chaukis* should, also, be isolated from the closed forests. I once found that a Range Officer had set a *Chauki* (made completely of grass), with two men in it, in the middle of an immense sea of grass, nearly as high as the hut, and growing up against it. If the Forest Officer himself does not look into things, unintelligence of this kind will occur in many directions. At the same time, I consider that our men are in this matter of Fire Conservancy, quite exceptionally deserving of praise in many ways. But the obvious sometimes does not strike them, and the result may be disastrous.

The walls of a fire-watcher's hut should not be made of grass, but of stones, with or without mud mortar, or of mud only, while if the roof cannot be made of anything but grass or branches, it should be lined on its underside with planks, or slabs, and the cracks filled with mud to prevent ends of grass twigs or leaves from hanging down.

It has been suggested that fire-lines should be cultivated. Possibly this might be feasible in a plains' forest, the tenant paying a nominal fee and living in a mud hut in the middle of the line. There could be no objection to his making a well. The difficulty would be the damage done to the crops by deer, yet one sees crops in forest clearings. A large extension of this system with the tenants, who would thus be "the men" of the Forest Department, might conceivably have very happy results, but would not be without its risks. With a system of annual renewal of permission to cultivate, any men of whom the Forest Officer had suspicions, could be turned out without the necessity for assigning a reason.

Lastly, I would like to air a theory I have long held, but never been able to experiment with, as to the way to deal with fires in Chir forest. When a fire occurs on a slope, one is generally unable to extinguish it either above or below, except at the ridge and the ravine, because it rushes fiercely up the hill, and counter-firing downwards would be too dangerous, while if one tries to counter-fire across the slope below the fire burning cones bound down the hill-side and light the forest behind. So that it is usually necessary to sacrifice the whole forest between the ridge and the ravine. But is has occurred to me that a roadway made along a contour half-way up the hill, sloping inwards, and with a continuous bank on its outer edge, might obviate both difficulties, and would also make a useful export line. The drainge of the road would fall into the inner ditch (which might advantageously be rather deep, as an extra means of catching the rolling cones), and find its way into scupper wells placed from point to point along the ditch. When the well gets full of water, the overflow would run off through culverts, which might take off at, say, a foot from the bottom of the well. A burning cone could thus neither pass over the road, because of the outer bank, nor under the road through a culvert, because it would be stopped at the bottom of a well.



a = Continuous bank, (inner edge vertical)
b = Sloped road surface. (exaggerated in drawing)
c = Ditch and well.
d = Drain.

I hope these notes, which are founded on experience, may be of some use, and may lead others to add more notes of their own on this all-important subject. As Forest Conservancy grows in such countries as America and Canada, they will probably look to us for guidance, and it behoves us to have as thoroughly effective a system as possible to show. When India follows the example of all the great Forest Departments of Europe, and establishes a "Research Bureau," the varying systems at present in force throughout the country for carrying out the same class of work (as, for example, Fire Conservancy) will be examined and compared, and all will then be able to use the best methods, varied to suit local circumstances, that the united experience of the whole Department has been able to evolve. It would be difficult to say how much waste may thus be saved, and how much improvement all round may thus be effected. In the meanwhile, all we can do is to publish our own experiences, but it is a lame, spasmodic and incomplete method at the best.

'H. H.'

Forests and Sub-soil Waters.

M. Ed. Henry has a long study of the above question in the Revue des Eaux et Forêts, and points out some important facts which cannot be too widely known, especially in a country like India, possessing large areas, practically desert now, which it is also practically certain were not desert even so recently as the time of Alexander. Since his time, there has been a great extension of cultivation, and a corresponding diminution of forest areas. At any rate, it may be admitted, that if the present cultivated area is not greater than the greatest of olden times, the old cultivated area has become largely desert, and the present cultivation has been acquired at the expense of forests. At the present time "extension of cultivation" is advocated by all, except Forest Officers, without the least regard for consequences.

During the last fifty years, the question has stirred Europe to a sense of the gravity of the situation, and various important commissions have been engaged in gathering evidence, and experimenting as to the facts. In 1875, the Vienna Academy of Science took the matter up with reference to the Danube, perhaps the most important river of Europe. It was found that the mean level of the Elbe and the Oder had sunk by 17 inches; that of the Rhine and the Vistula by 24 inches; and that of the Danube by 55 inches. The Engineers unanimously

agreed that the cause was to be found in the disforestments of the preceding fifty years. In 1880, a Russian Commission sat at Moscow to investigate the same subject. In 1894, M. Venukoff communicated a paper to the Paris Geographical Society. From 1830 to 1840, the question had been studied by M. Koeppen, who attributed the evil to disforestment. The Woronesh, on which Peter the Great of Russia built his first navy, is now a mere brook. The Oka is so shallow that boats habitually stick on sandbanks. In the Dneiper, a first class river, the depth of water is now reduced to 2 or 3 feet, and navigation has been abandoned. Even on the Volga the sandbanks have become such that steamers can only ply in a few reaches. The water it carries has diminished by about 825 millions of cubic feet. This is such a disaster, that even a Russian Minister could ignore it no longer, and a dozen specialists have been set to work to find a remedy. The whole of the fertile "black soil" region of Russia is affected, that is to say, some 240 millions of acres to the south of a line drawn through Kieff, Moscow and Kazan; and not only the Government, but the learned societies, the professions, and landowners of all classes are becoming exceedingly anxious. The Government has indeed issued orders prohibiting irregular exploitations, but it is feared that the harm is almost irretrievable and the orders too late.

This question is intimately connected with those of the circulation of sub-soil waters, of floods, and of the influence of forests thereon. The terrible floods of 1856 in France gave rise to immense discussions, the main outcome of which was a general opinion that forests must be preserved and bare hills re-clothed, and the result was the laws of 1860 and 1864, followed by 40 years of energetic forest work, which has already produced results whose remarkable success has caused the adoption of similar measures in other countries. For the last 25 years, no one has been found to dispute the beneficent action of forests on the flow of surface water. The matter of sub-soil water is, however, not so clearly settled, and the effect of forests on springs, wells, and the constant flow of brooks does not seem to be invariably the same. Generally, no doubt, a forest will maintain running springs and brooks, and will even create them on land formerly bare and dry. Nevertheless, there are a few cases in which an opposite action has been alleged, and the reasons for these exceptions are not clear. Even in India, it has been occasionally alleged that, the level of water in wells has been lowered by forests. There are two methods of solving this problem: (1) empirically, by cutting down, or planting, a forest as the case may be: (2) scientifically, by ascertaining the amount of rainfall and what becomes of it. The latter method appears to be rather difficult, so that the former is perhaps the more trustworthy. The expedition

of M. Ototzky investigated the matter in the southern part of the "black soil" area of Russia, but the conditions here are peculiar. The surface and lower strata are practically level, with three alternating layers of water-bearing sands and impermeable clays, and the rainfall is very small, not exceeding 16 inches in the year, including snow, in some places only 8 inches. The conclusion reached was, that the forest lowered the water level by the yard or more. The same result has been ascertained in certain parts of Italy and France. In Italy and North Africa, Eucalyptus has been planted with success in malarious swamps. In the Roman Campagna, plantations of Eucalyptus on a wet soil were so effective, that the water level sank to 2 feet below the surface. One case, however, not mentioned by M. Henry, may be cited as a very doubtful success. A certain monastery was so feverish, that for some months of the year the monks had to desert the place. After the Eucalyptus had been established, the fever disappeared and the monks could remain there all the year round. But after a few years the locality became as unhealthy as ever. In the dunes of Gascony and in Algiers, the maritime pine has been used for the same purpose, and has dried up large areas of marshland and converted it into useful pasture. The Russian forests on the other hand, are oaks. In general terms, there is an impression that broad-leaved species are preservers of water, while resinous ones are marsh-dryers. The facts are, nevertheless, to some extent contradictory, and require further explanation.

There are five questions which may be considered separately.

1. Is there more rain in forest or on bare land? This question, formerly doubtful, is now considered settled, All observations agree in showing that, in French forests for instance, the rainfall in forests is about 10 to 20 per cent. more than outside, as shown by the records of the last thirty years. The same holds true for Russia, and doubtless for other countries. Even the aeronauts record that the temperature falls in passing over a forest. In a country like India, this reduction of general temperature, and of dryness in the air, is no doubtful benefit. But omelettes are not made without the breaking of eggs. This coolness of the air is derived from evaporation through the leaves, and finally from the soil. A certain amount of moisture is necessary to plant leaves as well as to plant roots, but in very varying degrees. Some crops require a saturated atmosphere, some a comparatively very dry one. It may, therefore, be a question whether in a given locality the (1) greater rainfall of forests, (2) greater storage power, (3) general cooling effect, (4) supply of forest produce, do or do not outweigh the lowering of the level of sub-soil water, if this occurs at all. There can be but few cases in which the issue is doubtful.

2 How much of the rainfall actually gets through the canopy and into the soil? Canopies differ very much, but from many experiments it appears that an evergreen canopy may intercept as much as one half of the rainfall, while a deciduous canopy lets pass 65 to 91 per cent.

3. What are the quantities evaporated from a wooded and a bare soil, respectively? This question is practically unanswerable as it stands. Experiments, therefore, have been made on the evaporation from a sheet of water in the forest and outside. It is found that evaporation outside the forest is three times as great as inside. The effect of a covering of dead leaves on the soil is equal to that of a canopy, that is to say, that in a forest having both a canopy and a layer of dead leaves, the evaporation from the soil is only one-sixth of what it is outside. As above stated, however, these results are not exact, since the evaporation from non-saturated surfaces may not be the same as from saturated surfaces. It may, nevertheless, be accepted as perfectly certain, that evaporation from forest soils is far less than from open fields.

5. What quantity of water is absorbed by the roots? This question also is not capable of an exact reply. Experiments have been made by placing plants in pots, giving them a measured supply of water, deducting what has run through or been evaporated, and, considering the difference as consumed by the plant. Evidently, the results cannot be very reliable, especially as the same tree will consume very different quantities, according to the degree of saturation of the soil, in different years. It is agreed that the quantity is very considerable, but it appears certain that, for equal surfaces, forest crops evaporate much less than field crops: for instance, oaks consumed eight times less than lucerne, four times less than cabbages, three times less than wheat or turf. On the other hand, a forest transpires more than a field of bare soil. These results offer no kind of explanation of the fact that the Russian forests mentioned have certainly lowered the water level, so that this problem remains unsolved. Possibly, a canopy works at a faster rate than the young plants that can be experimented with. Probably the solution must be sought under more natural conditions, that is to say, with a dry soil and climate, and a very limited water-supply. The action complained of appears to be really due to the forest, since the water level under the fields is markedly higher than under the forest. A former Collector in Bombay proposed to clear all the forest on the drainage basin of the Tansa lake (about 10 miles long, Bombay-water supply), on the ground that grass would be more effective. To him may be commended the results of Ebermayer, who says that a forest distinctly contributes more water to springs, &c., than grass, bare soil, or crops. This may not always be the case on level plains with slight rainfall, but

even there the supply of forest produce is well worth some sinking in the water level.

M. Henry concludes that wherever there is no flowing surface water, forests will probably lower the sub-soil water level, but that in hilly country and wherever there are running brooks, the contrary effect may be expected.

F. GLEADOW.

Insects attacking teak in Southern India.

In April last, you were good enough to print in your magazine a letter from me, describing the ravages of a caterpillar which defoliates the Teak trees on our plantations in Travancore.

Perfect insects were subsequently sent to Calcutta, and were identified as *Hyblœa puera*, a moth whose caterpillar has been reported from Berar, Assam, Lower Burma, Dehra Dún and the North-West Provinces, as defoliating Teak in the same way. (See Indian Museum Notes III. 3. III.)

My object in writing to you now is to know if any remedies have been successfully tried elsewhere. Forest Officers who have had experience of this pest have doubtless tried remedies for its extermination, and I should greatly like to know what agents have been employed, and how far they have proved successful.

Our observations show that the caterpillar does not drop to the ground to change its skin, but that it remains on the tree where it was hatched from the egg until ready to pupate, when it spins a thread and drops to the ground. The painting of rings of tar or other sticky substances round the stems of the trees would, therefore, be useless, as the caterpillars do not apparently ascend the trees at all.

The sweeping up of all the fallen leaves and rubbish, and the burning of them after the insects had dropped to the ground, would probably diminish the amount of damage done at the next visitation, by destroying the moths before they had arrived at maturity, but fire is too dangerous an agent to employ in a plantation where there is much inflammable material lying about.

Passing through some of our plantations the other day, I was shown the first symptoms of an impending atttack. When the caterpillars are about to appear in numbers, the first indication of them is that the edges of the Teak leaves are seen to be folded over here and there for a length of about $\frac{1}{3}$ of an inch, and for a depth of a $\frac{1}{4}$ of an inch. On examining these folds, a minute caterpillar 1/12th inch long, and no thicker than a hair, may be seen concealed under each fold. The ragged appearance of the Teak leaves is, therefore, the first warning we get that an attack is about to commence.

T. F. BOURDILLON.

III.—OFFICIAL PAPERS & INTELLIGENCE.

Rubber of Cryptostegia grandiflora.

In June 1895 a despatch from Her Majesty's Secretary of State for India, to the Goverment of India, forwarded a copy of a letter received from the Director of the Royal Gardens, Kew, in which he asked to be supplied with a sample

of the rubber from *Cryptostegia grandiflora* for the Kew Museum. Mr. Thiselton-Dyer's letter ran thus:—

"I have the honour to inform you that an extensive 'climbing plant (Cryptostegia grandiflora) cultivated in various 'parts of India, "abounds in milky caoutchouc juice which is 'like India rubber"

'A considerable effort was made to extend the cultivation 'of this plant, both in Madras and Bombay, about 12 years 'ago. A sample of the rubber, about 3¼ pounds in weight, sent 'to this country in August 1893, was examined by the Silver 'Town Rubber Company. It was reported to be "hardly equal 'to Ceara rubber from Brazil, although its general qualities 'were very encouraging."

'Fuller particulars are given in the Dictionary of the '*Economic Products of India, Vol. II*, p. *625*, and also in the 'several official Reports therein quoted.

'No specimen of this rubber exists in the Museum of 'Economic Botany at Kew. I would therefore suggest that the 'Government of India be moved to procure a sample of the Cryp-'tostegia rubber, about one pound in weight, to form a part of the 'collection of Indian products preserved at this establishment."

Accordingly, a specimen was procured (it is not said from where), and duly despatched to Kew. Mr. Thiselton-Dyer then had the rubber examined by Messrs. Hecht, Levis and Kahn, of 21 Mincing Lane, who reported it to be worth, if properly prepared and cleared, 2*s* 6*d* per pound or more. Mr. Thiselton-Dyer's Report was as follows:—

'In reference to Lord Reay's letter of June 17th, 1895 '(R. and S. 861), and previous correspondence on the subject of 'rubber, produced in India from *Cryptostegia grandiflora*, I have 'now the honour to inform you that a sample has been received 'at Kew, upon which I enclosed the brokers' report.

'I find from a letter from H. N. B. Erskine, Esq., Commis-'sioner in Sind, dated the 5th of January, 1882, that the plant is 'common in many parts of India and yields juice which gives 'from 50 to 70 per cent. of good India rubber.

'It further appears from the Proceedings of the Madras 'Government (11th January 1884, No. 44, Revenue) that samples 'were sent for report to the India rubber, Gutta Percha 'and Telegraph Works Company (Limited), who reported that '"it is of fair working quality."

'It follows from these facts that India possesses a widely-'dispersed plant which yields rubber of commercial value. 'The only question is whether it would pay the cost of collect-'ing if plantations were made."

Cryptostegia is not common in India or indigenous, and only occurs in gardens, so that it would have to be cultivated. It is a climbing plant, and its method of propagation is probably easy in good soil. But we are not told how it is tapped.

Sleepers on the East Coast Railway.

A useful lesson is to be learnt from the experience of the East Coast Railway of certain sorts of wood for sleepers; *viz.*, that Some or Sumi (*Soymida febrifuga*), Pymma (*Lagerströmia hypoleuca*), and wood purporting to be teak from Johore, are all quite unsuitable for Indian use as sleepers. They all go utterly in four or five years. Probably to "Haskinize" them would greatly prolong their life. I saw some most excellent Sâl sleepers from the forests of Ganjam, and was told that their price in Berhampore was Rs. 4-8-0. Nothing better than these could possibly be wanted if there were only enough of them. The matter is one which might with advantage attract the attention of the Forest Department. I was told that Pyngadu sleepers from Burma cost Rs. 5-4-0. I here warn the East Coast Railway authorities, officially, that a Pyngadu sleeper ought always to sink, and that if a Burma sleeper, called Pyngadu by dishonest suppliers, is found to float, it is probably Kya Eng or other worthless timber, and certainly not Pyngadu. I was told that 25,000 Johore teak sleepers laid in 1895, are now rotting fast. I was toll in 1892 that a considerable number of them had passed on to the southern part of the North-Western Railway, through a large Karachi firm. It would be interesting to know what their life was in a dry climate.

NOTE.—The above extract from the last Report of the East Coast Railway has been received from a Madras correspondent, to whom our thanks are due. We wonder what 'Johore teak' is, and we should be still more indebted to our correspondent if he would tell us something of the sleeper-supply of the East Coast Railway. We presume that both Ganjam Sâl and Godavari 'Pyngadu' have been largely used.

HON. ED.

VI.—EXTRACTS, NOTES AND QUERIES.

Pineapple Fibre.

We see from Agricultural Ledger, 1898, No. 11, that the cultivation of pineapple as a fibre-producing plant has been taken up by the Hon. Mr. J. Buckingham, C. I. E., at Amguri, Assam. Specimens of fibre prepared by him have been sent to the Imperial Institute, and reported well of. The fibre is said to nearly resemble flax and to be suitable for spinning into fine twine, and if properly softened, for textile purposes. Its value is set down as from £ 20 to £ 25 per ton. We are not told how the fibre has been prepared from the leaf.

Cigar Boxes.

In the manufacture of cigar boxes three kinds of lumber are used, namely :—Cedar, veneered cedar, and imitation cedar.

There are three kinds of cedar, namely, Spanish cedar, Mexican cedar, and South American cedar.

The first named is considered the best, because it retains the flavour of the cigar. Some cigar manufacturers claim that it improves the flavour. The reason for this is that this lumber

grows in the same localities as the Havana tobacco. Therefore, a box made of this lumber is the only one in which a clear Havana cigar should be packed. No cedar grows in the United States that could be used for cigar boxes. A cedar growing in Florida has been tried, but was not satisfactory in any particular. All this lumber is imported in logs and shipped to New York City, where it is cut up ready for use. Seven-eighths of the cedar lumber used in the United States is shipped from New York. On account of the present crisis in Cuba, it is almost impossible to obtain Spanish cedar at any price.

The South American and Mexican cedar does not have as good a flavour, and contains a gum or sap which often ruins the attractive labels on cigar boxes. This lumber is now mostly used because no other can be had at present.

The price of cedar lumber is about the same as it was thirty years ago, while the price on boxes since then has been cut one-half, although the price now is higher than it has been in three or four years, due to the war in Cuba.

Almost any kind of lumber can be used for making veneered cedar, of which there is not as much used as genuine cedar. A great many of the cigar box makers use this lumber for frames, and genuine cedar for tops and bottoms. This makes a cheaper box and answers the purpose almost as well. In such a box medium grade cigars are packed.

Imitation cigar box lumber is made of poplar, elm, bass, and gum wood, so as to imitate the appearance of Spanish cedar. On account of the high price and scarcity of Spanish cedar more of this lumber is used than any other.

The poplar imitation gives the best satisfaction, while the bass wood makes a better imitation, but there is a strong objection to its odour. Elm wood also makes a good imitation, but on account of its being so hard it is not used so extensively.—(*The Barrel and Box and Timber Trades' Journal.*)

The Hasselmann method of preserving Railway Sleepers.

A new process for preserving railway sleepers is the Hasselmann method, which has been adopted on several Bavarian railways, and is said to be perfectly effectual and cheaper than the processes involving the use of tar-oils. The sleepers are first boiled in a solution of the sulphates of iron and aluminium, and then in a lime bath under pressure. All putrefactive bacteria present are, of course, destroyed,

and the cellulose of the wood becomes thoroughly impregnated with iron and alumina, which protect it from weather and damp and the other influences which bring about the rotting of wood.--(*Timber Trades' Journal.*)

A Miraculous Palm Tree.

The most interesting passage in his article is that in which he describes the marvellous tree, which grows like a weed in Brazil, but the like of which is unknown in any other part of the world. It is the carnahuba palm (*Copernicia cerifera*), which grows uncultivated in the States of Parahiba, Ceara, Rio Grande do Norte, Piauhi, and some of the neighbouring States. The descriptions given of it to me seem incredible. Perhaps in no other region is a tree to be found that can be employed for such varied and useful purposes. It resists intense and protracted droughts, and is always green and vigorous. Its roots produce the same medicinal effects as sarsaparilla. Its stem affords strong, light fibres, which acquire a beautiful lustre, and serves also fo joists, rafters, and other building materials, as well as for stakes for fences. From parts of the tree wine and vinegar are made. It yields also a saccharine substance, as well as a starch resembling sago. In periods of famine, caused by protracted droughts, the nutritious substances obtained from it are of immense benefit to the poorer classes. Its fruit is used for feeding cattle. The pulp has an agreeable taste; and the nut, which is oleaginous and emulsive, is sometimes used as a substitute for coffee. Of the wood of the stem musical instruments, water-tubes and pumps are made. The pith is an excellent substitute for cork. From the stem a white liquid, similar to the milk of the cocoanut, and a flour resembling maizena may be extracted. Of the straw, hats, baskets, brooms, and mats are made. A considerable quantity of this straw is shipped to Europe; and a part of it returns to Brazil manufactured into hats. The straw is also used for thatching houses. Moreover, salt is extracted from it, and likewise an alkali used in the manufacture of common soap. But from an industrial and commercial point of view, the most valuable product of the carnahuba tree is the wax obtained from its leaves.

Was there ever such a tree described before? There are many British colonies whose climate is not unlike that of the Brazilian States in which the carnahuba palm flourishes. It might be well worth Mr. Chamberlain's attention to conduct experiments to ascertain whether or not this marvellous tree could not be naturalized in our hotter colonies, which are, at

present, in need of some help from without.—(*Extract from Review of Reviews of an article in the Forum for March, by* HON. T. L. THOMPSON, *late United States Minister to Brazil.*)

The Best period to Fell Trees.

To determine whether a trunk was hewn in winter or in summer is of the greatest importance to buyers of timber, especially as regards building timber, since it is well known that timber cut down in summer represents a lower value than that felled in winter. Timber hewn during the resting period, *i. e.*, between October and April, contains in its cells numerous starch particles which cannot be found in wood cut down in summer. Owing to this presence of starch the wood is coarse and impenetrable, since the starch closes the pores. For this reason, winter-hewn timber is exclusively employed for staves, because, with staves from summer-hewn wood, the contents of the barrels are subject to evaporation through the pores. The starch contained in the winter wood is given a violet colour by iodine. Hence if the timber to be examined is coated with an iodine solution, and the surface of the felling side appears yellow, it may be assumed with certainty that the respective tree was cut down in summer. The light yellow lines are the moisture rays, while cells, tissue, and wood fibres simply take on a yellow colouring. In the case of winter-hewn timber, the amylaceous rays form much darker, ink-coloured, black stripes on the yellow ground.—(*Allgemeine Tischler Zeitung and Public Opinion.*)

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The most Suitable Method of Treatment to apply to Sal.

It is now a considerable time since Improvement Fellings in Sâl forests were first introduced, and already some of the original Working Schemes are approaching the period of revision. It, therefore, behoves us to begin to consider the effect of these fellings, and whether or not we can start to work on regular methods of treatment.

Improvement Fellings were introduced in a sort of despair, and admittedly as a temporary measure; it was considered that the forests were too ruined, or too irregular, to satisfactorily allow of an immediate application of regular methods, and it was therefore proposed that a preliminary run through with Improvement Fellings should be made to allow of the forests growing up a little under protection, and in order to remove, as far as circumstances would admit, the old bad stuff on the ground. It is possible, Improvements Fellings have sometimes been prescribed for forests which might have been at once put under regular treatment, but even with these, if the fellings have been cautiously made, there has probably been a gain. For one thing, it was safer to make Improvement Fellings incorrectly, than it would have been to make errors in a regular method. There have often been bad mistakes in the markings during these early years of Working Plans, but we can but acquire our experience, and as year by year our Range Officers learn their work, things must improve. No doubt the time during which we have been training our Range Officers has been less harmfully passed with Improvement Fellings, than had we had regular systems to attempt to apply.

But Improvement Fellings have, as has been pointed out—by Mr. Hearle, I think—one grave danger; *they prescribe no volume check.* The irregular condition of the forests, and especially the

irregular growth of the individual trees, would probably have rendered any attempt to fix a volume check impracticable. Some may, indeed, argue that the material in the forests was so bad that really the sooner we removed it the better, provided only we were careful to establish in its stead a re-growth on the ground, of a better-grown class of trees, and it might be added that we should then be arranging to have the annual increment put on in its right, instead of in a wrong, place, on straight, sound trees, instead of on crooked, hollow ones. But, if we followed out this principle logically, we should at once work for a re-growth throughout the area, and in removing the old material, go only as slowly as the difficulty of selling it, or of getting up a re-growth, obliged us. But Sâl is very prolific, and a re-growth of young trees not difficult to establish, while the cases where Sâl forest has been cleared for cultivation show the insatiability of the market. We should then rapidly acquire a very valuable *potential* property, but our revenue would fall with a violent jerk for a long period, until the new young forest had grown up, and then it would be nearly of an age throughout, which would be inconvenient.

This omission is a very great danger undoubtedly, but it is not the only risk of Improvement Fellings. The rotations adopted are necessarily small—10, 15, or 20 years—and the result is something like that of Selection, namely, an interruption of the canopy in a great number of places *throughout* the Working section. Even if (in Selection) all the holes in the upper canopy contain, down below, a crop of seedlings, still side-light can get in, and in consequence there is a growth of grass and weeds. A French Forest Officer lately pointed out to the writer that the Selection method encouraged the growth of brambles in Beech forests. And this will mean that the difficulties of fire-protection will extend to the whole area of the Working section.

Prudence, therefore, seems to point to our losing no time, wherever the nature of the forest growth will at all admit of it, in introducing some regular system of treatment. This will give us a regularity of outturn, and a concentration of work and re-generation within a limited (and so more easily protected) area, while the remainder will grow up thickly, and both guard itself against dangerous fires and give to the soil the great benefit of a long period of complete cover.

If we have seed-bearers enough to start with and a sufficiency of trees throughout which will bear seed by the time the regeneration felling reaches them, a regular high forest system can be introduced. Shortly, we should begin in the oldest part with our regeneration fellings, and deal with the remainder by very cautious thinnings, our great aim, in these parts, being to produce a very close overhead cover till the approach of the regeneration cuttings.

In at once applying a regular method to an irregular forest we shall meet with some *inconveniences.* (*These would not* apply to the same extent to the Selection method, but, as noted hereafter, there are certain objections to Selection). Firstly, our full-aged trees will *not* be *only in the periodic Block about* to be regenerated, but throughout the Working Circle. In the later periodic Blocks these older trees will have to be removed in the thinnings, which will mean *that the thinnings will* assume the appearance of Selection in greater or less degree as the full-aged trees are more or less numerous. This will, no doubt, be something of a drawback, but *will cure itself in* time. In the next place our first periodic Block will contain, besides full-aged trees, younger trees of many different ages, whether well or badly grown. To fell these to make room for a new young growth would be a little wasteful. In the first place, however, we need not regret the removal of these younger trees when defective, and the number of such trees will be sure to be great. Then the smallest class (say saplings as *opposed to* poles) need not be touched, but can be included in the future stock. Thus, our difficulties will be considerably reduced, and if we adopt the Group method, which has a long *periodic* Block (say one of 40 years), we can arrange to leave well-grown poles to grow at least till the end of the period. Thereafter isolated poles could still be left to grow on, and fall *in the* thinnings. *Groups* of tall poles of a similar age should not, we think, be left to grow on, because they would all become full-aged at roughly the same time, and consequently in *coming* away would leave a gap. We should in fact have to compromise to some extent in the introduction of a regular method, and be content to reach complete regularity by degrees.

Although Sâl would do admirably under coppice with standards, or even simple coppice, yet it is essentially a timber tree, and because of its strength, one especially in demand in longsawn pieces. Sâl poles are valuable, but longsawn Sâl beams greatly more so, and as for fuel it is relatively worthless, and can, moreover, be obtained to excess otherwise in the forest. Then, coppice means great exposure of the soil at frequent intervals, which, if so detrimental in temperate and humid Europe, is surely ten times more so in torrid India. Evidently, then, Sâl should be treated as high forest, unless there is some very special local reason against it. For private proprietors coppice may perhaps, however, be in place (*vide* Mr. Fisher's article at p. 151, Vol. X of the *Indian Forester*). The question then arises, under which system of high forest should it be worked? For the reasons which follow, I am of opinion that the Group *method* will be the best, but a Group method approaching as nearly as we can get it to the Uniform method (Shelterwood Compartment System of Schlich).

The chief objection to Selection has been already stated above; it connotes a dangerous state of things from the point of view of fire throughout the forest. Then there are the various reasons (unnecessary to recapitulate here) advanced by European Foresters for preferring the Uniform system to that of Selection, and relegating the latter to forests of protection. In addition, it is said that with Selection the young trees very often have to undergo a more or less lengthy period of suppression. I will add one more objection, which I have noted in Beech woods, but have never seen in any Manual, and which I think will apply to Sâl, namely, that the system produces crooked trees, which have struggled round towards the opening from under the cover of the trees surrounding the holes made for regeneration purposes in the upper leaf-canopy, and fought their way up against those growing more directly under the light. As a rule, and theoretically, the latter should no doubt grow up quicker than the former, but actually we constantly find trees which have twisted round and worked their way into the intervals in the canopy.

The objections to the Uniform method are that in India the sudden and almost complete uncovering of the soil over large areas (as is done in regeneration fellings under this method) leads to very rapid degeneration of the soil, to an appalling growth of grass, and to great risk from fire, frost and drought. I am not prepared to say that Sâl seedlings will not, in time, overcome this heavy grass, and they will often, no doubt, grow through grass vigorously when uncovered, if already present, but the risk of heavy grass is very great, and the success of regeneration in it will of course be open to doubt, while the too liberal opening out of the cover may bring on the insuperable difficulty of frost. But the Uniform method has this advantage, that it concentrates its regenerative operations within the smallest possible space, the remaining periodic Blocks growing up as self-protected, long-boled timber. Doubtless most of us can recollect areas of straight, high Sâl forest, with nothing but leaves on the ground, resembling a periodic Block of a regular forest soon to come under regeneration; and nothing is commoner than Sâl poles growing in masses like a bit of forest just entering the period succeeding regeneration under the Uniform system. Of the former, the most striking example the writer knows is (or was) the Lakhman Mandi Block of the Kumaon Division (N-W. P.), where the trees were 90 feet high, with straight, clear, very long boles, and restricted, but well-shaped crowns, while on the soil was nothing but *Clerodendron* and thin Gauj (*Millettia*) stems, these latter being quite harmless and unable to make any way, though doubtless they would start to grow immediately if the light were let in.

The regeneration area of a Uniform forest will be perhaps one-sixth or one-seventh of the total area of working section, while that of a Group forest will be from one-third to one-half, which is a great disadvantage. Still it is not so much of a disadvantage as those which apply to the Uniform method, and the assured re-growth of the Group system is of incalculable value.

But it is not unlikely that the very prolific nature of Sâl, and its love of light when once established, will allow, in practice, of our working the Group method much on the lines of the Uniform system, more especially in a forest which, having passed through a rotation of Improvement fellings, has already a well-distributed stock of seedlings. The fact that Sâl will germinate in moderate shade, will bear this shade for some time, and, when released, will go ahead, will generally result in our having seedlings, more or less, in all parts of the Block, and allow us in consequence a number of points to choose from for our fellings. Thus, when we come to apply the Group method of regeneration, we shall probably be able to begin by working more heavily in one-half of the periodic Block, and obtain the amount of material (or number of trees) ordered to be annually removed, from this half, and then gradually work, with a rough regularity, from this side of the Block across to the other. While the fellings are proceeding more heavily in the one-half of the Block, parts of the other will grow up closely enough to render its fire-protection less difficult than it would otherwise be. Thus, with a period of, say, 40 years, the earlier years would see us working, as far as circumstances permitted, in one-half of the Block, with lighter fellings, at the same time, in the other half; and during the second-half of the time the bulk of the fellings would pass into the second-half of the area. In this way we should be working, as far as we safely could, on the lines of the Uniform system, and do away to a great extent with the disadvantage of a large periodic Block. We shall have a compromise between the Uniform and Group systems, holding to the greater safety (from the regeneration point of view) and the other good points of the Group system, while obtaining, too, as far as circumstances will allow, the advantage of the restricted regeneration area of the Uniform method.

It will no doubt at first sight appear unnecessary to have a large periodic Block, if, as above suggested, we work from one side of the area across to the other, but as a matter of fact we could not with safety tie ourselves down strictly to a small periodic Block. All we can do is to work, *as far as circumstances will permit*, across from one point to another, and we must allow ourselves elbow-room, as it were, to fall back upon in case our advance growth in the part we are trying to work the more heavily, is not for the moment in a state for further fellings. Regular methods (except Selection) have not as yet been applied to Sâl, and we have yet to learn how quickly or slowly it is advisable to move in clearing

away the overhead stock to reproduce the forest. It is evident that the more quickly we can safely go, the smaller can our periodic Block be, but as to start with we must fix our period arbitrarily, or nearly so, it behoves us to give ourselves a margin of safety. The experience of the first period will give the officer revising the Working Plan much to go upon in drawing up his prescriptions. Thus, for example, we might in the first instance fix on 120 years as the rotation, with three 40-year periods, but the experience of the first period, or supposing the revision was to be in 20 years, —that of the first 20 years,—might lead him to order six periods of 20 years each, or a different length of rotation and other periods, and so on ; but we must of necessity grope in the dark till experience comes.

Presuming that we adopt the Group system, it will be necessary to fix a check for the annual outturn during the first period. We might calculate the total value in the first periodic Block by working a linear survey across it, from which we should ascertain the number of trees, arranged in diameter classes, and again in height classes, and then fell and cube type-trees for each class. This done, we should have the cubic contents of the stock on the area traversed by the linear survey, and multiplying this by the total area of the periodic Block, should arrive, after a fashion, at the total cubic contents of the stock in the Block. But this method is open to serious error. It would surely be safer, besides being far simpler, to count the standing stock, omitting the smallest class from the calculation, because so much of this latter class, as is well grown, may advantageously be absorbed into the new stock, while the badly-grown individuals would be of small practical value beyond fuel. If it was considered too laborious to count over the whole Block, a linear survey might be adopted, but it would certainly be better to count the whole stock. The number of trees divided by the number of years in the period will give the number of trees to fell annually, and there will then be no risk of finding ourselves at the end of the period with an excess or deficit which with a volume check, however carefully fixed, would be inevitable. It may be objected that if we have no check but the number of trees, the outturn in cubic feet may vary greatly from year to year. That might be, but personally I doubt it, and if it did I do not think it would matter very much. There will be a number of Working sections in the Division, and the fluctuations in their several outturns are pretty certain to cancel against one another. The marking, too, will be simpler, and therefore better done, if not complicated by having to estimate the cubic content (for we could only estimate) —a thing which would be pretty well impossible to do correctly and most laborious—while the marking was going on and the trees still standing. Another great difficulty with a volume check

would be to find what figure we must add to allow for growth during the period itself. Altogether, Volume would be so difficult to work by that we shall do well to give up the attempt. But to fix a number of trees, will, I think, very fairly meet our purposes, and provide the necessary check. The second periodic Block, when fixed after the close of the first period, would be dealt with in the same manner, of course.

As the fellings proceed, we might usefully measure, each year, a certain number of trees in the various diameter classes, but in doing this it will be necessary to recollect that the new class of forest which is about to grow up will consist of trees regularly grown, whereas the old material has come up under irregular conditions. Therefore, the trees to be measured must be carefully chosen, those only being taken which show boles and crowns of the kind we are expecting in the next generation.

The remaining *periodic Blocks will steadily close up during* the first period, and it will be our business to do our utmost to bring about as dense a leaf-canopy as possible, so as to kill out all the grass and render the forest practically fire-proof, and to ameliorate the condition of the soil. When an area has once been thoroughly purged of grass by a long spell of cover, it is practicable, I believe, to somewhat slacken the density of the cover, as in such an area the grass cannot immediately return. But in the first instance we should arrange to close up the canopy to as extreme a density as possible, and completely eliminate every bit of grass. Probably this will be satisfactorily accomplished before the end of the sapling stage of growth. Nor is it sufficient to have the crowns merely meeting overhead; we must get the vertical depth of the canopy as great as the species will permit of. I cannot say quite what this will amount to with Sâl, but with Beech we often find that, although to all appearance we have a very fair density of cover, yet there is a growth of bramble, more or less profuse, on the ground, and I can only attribute this to a want of depth in the cover. With this object, then, we shall do well *to leave even suppressed trees alone until they actually begin* to fall off, which will be a sign that the cover which is suppressing them is dense enough for our purposes. Once, however, the grass and weeds have completely disappeared from the soil, we can thin a little more freely, and diminish the acuteness of the struggle among the trees, while ever keeping a close watch against returning grass. It is indeed our object to bring on to the ground a certain number of seedlings in advance of the regeneration fellings, this being the very essence of the Group system; this will require a more open cover in the later stages. Our theoretical working will consist of a gradual removal of the old stock in precise measure as the seedlings take its place, and if only we could regulate this perfectly, no part of the Working section would ever be without either an old or a young

stock upon every yard of its surface, and the transition from one rotation to the next would be imperceptible. Doubtless we can only approximate to this ideal, but Sâl will, at least, germinate well in shade, and thus in advance of the felling, and if its first year or two are so passed, the seedling will probably be all the better provided with a root appendage, and with the strength necessary to survive and thrive, by the time light reaches it.

Thus a forest worked by the Group method seems to come up, as nearly as circumstances will allow, to our theoretically perfectly grown forest. Such a forest I take to be one in which there annually arrives at maturity (and is removed) just that number of trees, no more or less, which, when measured up, will together give an outturn equal to the annual increment of the forest, and while at the same time the soil is kept at its maximum of production, the trees not yet arrived at maturity are carried forward steadily at just that condition of closeness which causes them to produce both the maximum quantity, and the most useful shape of wood. The Group method, on the whole, seems to come as nearly as can be managed, to this ideal.

There is, however, a difficulty connected with thinnings. It would be theoretically most correct to pass through the forest, save the youngest woods, at short intervals, and whenever a struggle preventing that condition of development which we desire is discovered, to relieve it, but such a course would be impracticable for many reasons easy to see. Its correctness might even be denied, on the ground that a forest must be allowed rest, but I think the objection would be groundless, because when thinnings are repeated often, there will be but little to remove at any given point, and a thinning, properly made, is nearly always done with a light hand. So that the disturbance would be almost nil, more especially among even-aged trees. But though only a tree here and there will be cut, causing little commotion in the forest, the total outturn of these fellings will not be insignificant. In practice, thinnings can only come round as often as external circumstances will allow, but it seems to the writer that every effort should be made to render the thinning rotation as short as possible. Every forester will remember how when making thinnings he has here and there found places where the trees are struggling hard together, and where consequently the struggle must have been in progress already for a considerable time. In such cases has there not been a loss of development, which might have been prevented had the forester stepped in sooner? With a comparatively long period between thinnings, one must either cut away trees which are already doing much harm, this being a case of a past loss of development, or remove trees in advance, and before the psychological moment, lest before the next thinning they will do harm, and this is a case of preventing full development.

While on this subject of thinnings, we may usefully point out how advantageous it would be (and even more so—much more so—in regeneration fellings than in thinnings) to do our work a good deal by merely lopping branches, instead of felling whole trees. It so very often happens, especially in irregular forests, that a tree on one side is doing much harm whereas on the other its presence is useful. Then there are large species, like Haldu (*Adina*) and the figs, which use up large spaces in the forest, and the removal of which as whole trees will make large interruptions in the canopy. They are often, moreover, very difficult to cut down entirely, and would further, in falling, smash numbers of other trees. Girdling can often be usefully done, thus saving the damage caused by felling, but it is often difficult to successfully girdle figs, haldu, and other species, and, as in the case above, it may happen that it is only one side which needs to be cleared away. The writer has often in practice found the value of lopping in place of felling, while working Improvement Fellings. With a little patience one can manage to find men who can climb, or who will learn to climb, and the formation of a class of climbers (who will have to be well paid) will be of the greatest use—more especially for the purpose of lopping off the branches of large trees about to be felled in regeneration fellings, or among surrounding trees of smaller size in any operation.

We have above been considering the application of the Group system to Sâl forest of the kind most usually found, that is, forests which have suffered from over-felling and other damage in past times, and which are now-a-days almost universally, I believe, being dealt with by Improvement Fellings. But there are also, here and there (as in the hinder parts of the N-W P. "Bhabar" Divisions), forests which have not in the past suffered at the hands of the iconoclast. Such forests contain large timber scattered throughout, and are usually at present under Selection Plans prescribing the removal of a number of trees (up to a given maximum), of over a given girth, from a given area. If, as I think would be advisable, these Selection-worked forests were gradually brought under the Group method, we should still have to remove the full-aged trees from the periodic Blocks not undergoing the main regeneration operations, and Selection would consequently continue to be applied in the later periodic Blocks. Before closing this article there is one important point which needs consideration, and which, though it will not concern all Sâl forests, very greatly concerns some. This is the presence of bamboos in the Sâl forest. Their action appears to be very much the same as it is in relation to Teak ; they prevent a re-growth. I base this on observation of the Sukhrau Block of the Ganges Division (N.-W. P.). This forest consists for the most part of an upper stage of healthy, but crookedly grown and not very numerous, Sâl, with the intervals between the trees occupied very often by thriving

bamboos. It was closed to fire and grazing somewhere about 1882 (not later in any case), and has never been burnt. The writer saw it in 1883 and 1897; the Sâl reproduction had just about the same appearance in both years. This want of progress is most marked and I can only attribute it to the bamboos. As far as I can remember, the bamboo revenue of this Block is about Rs. 2,000 every second year, while the area is, I think, some 1000 acres. A bamboo Block may produce more revenue than if it were under Sâl, and yet it may conceivably be well to eradicate the bamboos for the sake of the Sâl, since there are many areas not suitable for Sâl, which will bear bamboos, and because Sal will stand a greater length of carriage by reason of the smaller space it takes up relatively. Where there is no doubt that Sâl is, and will remain, more valuable than bamboos, the operation seems called for at once. This same Ganges Division is a case in point. Although it is far the most valuable bamboo Division in the N-W. P. and Oudh, its bumper year showed a bamboo revenue of Rs. 1,21,000 and 10,000,000 bamboos exported) yet only half the area can be annually thrown open to cutting, and the more distant parts either do not sell at all, or sell very badly. If, then, the area under bamboos were decreased, the less paying parts would probably rise in value. It is, of course, very much open to argument, but it seems to me that the true sylvicultural principle for working bamboos would be to work intensely and cut annually, reserving a given number of culms (including those of the last rains) per clump. Were Sâl encouraged at the expense of the bamboo, it is probable that nothing short of eradication of the rhizomes would suffice. Such a measure would, of course, require the most careful consideration of all the local circumstances, but at present it does seem that in a struggle between Sâl and bamboo the latter triumphs, and surely the matter is one which cannot safely be lost sight of.

I fear this article is very full of theory, but until the Sâl has actually come under regular treatment, we *can* only theorise. It will, too, be admitted that it is useful to begin by setting up a theory, and thereafter correct it as practice may show to be advisable. In any case, Mr. Editor, I claim your sympathies, since it was you yourself who, some years ago, suggested to me the idea of applying the Group method to Sâl forest.

H-H.

On Suitable Seasons for Coppice Fellings.

The question of the most suitable season for coppicing, raised by a memorandum by Mr. Fernandez, reprinted in the September number of the *Forester*, is one of great theoretical interest, especially in Circles where large areas are operated upon and the public or great industrial concerns are dependent on the outturn; its practical importance, however, must in a great measure depend on how far local circumstances will permit an adherence to sylvicultural requirements. The period of felling is limited, apart from these reqirements, by the effects of climate, by the opportunities for labor and carriage, by the contract time of delivery and so forth. The unhealthiness of the late autumn may thus prevent the commencement of work so soon as desirable; labor and carriage may only be to hand during the seasonal cessation of field work; or the purchaser may, owing to the exigencies of his business, be obliged to fix for the delivery of the perishable produce of coppice fellings, a time inconvenient for forest interests.

On the other hand the sylvicultural requirements of coppice fellings demand, as pointed out by Mr. Fernandez, that these operations should be complete before the period of vegetative activity sets in; in all probability not less than two or three weeks before that date, in order to allow recovery from the shock of somewhat drastic treatment and the adaptation of the plant to the novel conditions imposed on it. This surmise is tenable when we recall the evident symptoms of malaise following much more trivial interference with the even life of a plant. The mean time of inauguration of vegetative activity must indeed be easy to fix for the various latitudes and species with which the forester has to deal; but here again only wide views can be taken, and, if coppicing operations are extensive, then the date fixed for their closure must be to some extent arbitrary, for we can only strike an average for the area comprised in one Working Circle and in doing so favour the most valuable species, whilst remaining uninfluenced by the frequent irregularities in the season so typical of Indian climates. However, a calculation even so vague as above indicated, would, in practice, suffice where large areas are concerned, were it not that we are again confronted with further difficulties in that local variations in aspect, soil and moisture render a decision based on generalities of latitude and climate often of no value whatever. Instances of such local differences will occur to every forester. For example, vegetative activity evidenced by the spring flush of foliage, appears to be retarded by a high water level, which seems to favor a retention of the old foliage, owing perhaps to an unusually copious water supply. Such delay may extend over a period sufficiently long to curtail seriously a short working season. Again, our coppice forests may, and

often do, stand on poor and shallow soil where the contained moisture does not, in the dry season, suffice to arouse the vegetative activity of the plant. In extreme cases in northern latitudes, we may even find that a leaf flush occurs in the winter season when air and surface soil are saturated, that it is absent in the spring and re-occurs at the break of the summer rains. These and similar irregularities might throw out our calculations and go to prove once more that however precise forestry may be in theory, yet in Indian practice we are only able to apply our knowledge in generalities and for the good of the forest as a whole.

So far, we have considered only the obstacles which may be met when we endeavour solely from the stand-point of sylvicultural requirements, to fix rigid periods for the prosecution of *coppice fellings. Far more important factors have already been* indicated in the commencement of this paper. Let us suppose that the forester has, after due consideration of all the circumstances of the case, decided on the season most suitable for coppicing in any Working Circle, that he has expended much forethought on the demands of species, soil and other influences, and fixed those approximate dates for his fellings which are most desirable for the forest as a whole. So far, his researches are only of technical value, and it may not be possible, owing to local conditions, to give effect to the result of the investigation. It is evident that we can only carry out our fellings when the forest is to a certain extent habitable and when labor and carriage are available; and that, whatever the requirements of the forests, if the Working season and the period of least vegetative activity do not coincide, then so much the worse for the forest, for we must have the fuel, and it must be cut and removed at that time when nature permits, and when men and cattle will do the work at the pay we can offer. Thus, though research into technical details may be interesting, it cannot in the case in point induce any beneficial changes in working, unless the period when work is possible extends throughout the whole, or a greater portion, of the year, thus enabling the forester to select that season most appropriate from the sylvicultural point of view. In Northern India, the flush of foliage occurs in April, and vegetative activity is fairly quiescent by the end of September. Outside this period coppice fellings proceed because the forest is accessible and labor plentiful. It is indeed probable that in the largest proportion of the area worked, this period is sylviculturally most suitable, but this is a fortunate coincidence in which the forester has no hand. So many factors are necessary when we wish to compare the quality of coppice growth, that one may well fear that any undue stress laid on one factor should vitiate the conclusions arrived at.

We have (*a*.) The season of felling,
(*b*.) The method of felling,
(*c*.) The age of the Coppice stools,
(*d*.) The height of the permanent water level,
(*e*.) The quality and depth of soil,
(*f*.) The climatic influences of the past as compared with the present year, and
(*g*.) The direction and intensity of light.

This last indeed has perhaps the most immediate and direct effect on the annual growth. We have all seen cases where excessive caution in the felling of coppice under standard, has involved repetition of these fellings and loss of increment. Some of us can point to forests where, on the other hand, in attention to local conditions has thrown back the forest growth for many years; and it may be advisable in estimating the value of coppice growth, first to take this and other factors where the influence of man is at work, into consideration, before proceeding to classify the results from natural causes. One can but admire the courage which in the Central Provinces has inaugurated over a lengthy period a series of measurements in several divisions on numerous sets of seven sub-sample plots. Experience of the difficulties attendant on accurate records of this description, has tended elsewhere to lead to a reduction in the number of recording stations, although there is theoretically no doubt of their value. In this instance, at least, we need not impose a burden, hard to borne in these days of inadequate staff and measuring responsibilities, before first judging of the necessities of each case. To do so, let us first eliminate from the calculations that portion of the year when coppice fellings are impossible and, from our comparison of growth, these causes in variation in growth beyond the choice of the season of felling for which man is directly responsible. This contraction of the field of observation will then, in most cases, be so considerable as to render us content to await the result of investigations in the Central Provinces without affording active assistance.

O. C.

On growing American India-rubber trees in South India.

BY MR. R. L. PROUDLOCK.

Of late I have given considerable attention to the chief American rubber-producing trees of Burliar (elevation about 2,600 feet), where the following species are growing, namely :

(1) *Hevea braziliensis* (Para rubber tree).

(2) *Manihot Glaziovii* (Ceara rubber tree).

(3) *Castilloa elastica* (Central American rubber tree).

Hevea braziliensis (Para rubber tree).—Of *Hevea* only a single tree exists in the upper garden at Burliar. I measured it on the 3rd March 1898 and the measurements were as follow :—

		FT.	IN.
Height	...	66	0
Girth at the base	...	4	2
" at 3 feet from the ground	...	3	$4\frac{1}{2}$
" at 4 " "	...	3	4
" at 6 " "	...	3	2

It has a clean bole of 10 feet, above which the stem is trifurcated. This, I think, is the identical tree raised from cuttings received from Mr. Ferguson of Calicut, by the late Mr. Jamieson, and planted in 1881. It will, therefore, be about 16 years old. This species yields the finest quality of rubber, which, when clean, always commands the highest price in the London market. The single tree at Burliar is growing luxuriantly, and appears to be perfectly at home. I have, however, not seen it produce any seed yet. Very considerable attention has been, and is being, paid to the Para rubber tree by Mr. Willis, Director of the Royal Botanic Gardens, Peradeniya, and by Mr. Ridley, Director of the Botanic and Forest department, Straits Settlements, Singapore. Both these gentlemen have recently written and issued instructive articles on rubber trees in general and on the Para rubber tree *in particular. With regard to forming plantations of Hevea, I* think it advisable to form them in moist situations from sea level up to 3,000 feet in rich soils. Such suitable situations can be found on the margins of rivers and mountain streams, especially near their debouchures on the northern, western and southern sides of the Nilgiris—the eastern side being perhaps rather too dry for this species.

Manihot Glaziovii (Ceara rubber tree).—There are several trees of different sizes of this species at Burliar, but with one exception they are all quite young and unfit for tapping. The exception I refer to is a tree measuring 5′ 4″ in girth at the base and 4′ 11″ at 2 feet from the ground. The measurements were taken by me on the 3rd March 1898. It is the oldest tree of Ceara at Burliar, and is probably one of the seven planted in 1879 by the late Mr. Jamieson. It will therefore be about

eighteen years old. I also tapped it on the 3rd March, 1898, and *obtained* $1\frac{3}{4}$ *ounces of dry and fairly* clean rubber from it within four hours. On again visiting the garden on the 17th March, I picked off all the rubber from the same tree which had oozed out subsequent to my visit on the 3rd idem, and which amounted to five-eighths of an ounce. The net result from a single tapping and two collections was $2\frac{3}{8}$ ounces of dry rubber.

The Ceara is quite at home, and produces seed abundantly every year at Burliar. It will grow almost anywhere on the Nilgiris up to 4,000 feet and in almost any soil, no matter how barren and dry it may appear to be. It will grow well in situations along with the Para and the Central American rubbers, and equally well, if not even better, in other situations which would prove altogether too dry for them.

Castilloa elastica (*Central American Rubber*).—There are two trees of this species apparently quite at home at Burliar. I measured them on the 3rd March 1898, and their measurements were as follow :—

		FT.	INS.
Tree in Upper Garden.	Height	55	0
	Girth at 1 foot from the ground	4	10
	,, at 3 feet ,,	4	4
	,, at 4 ,, ,,	4	0
	,, at 6 ,, ,,	3	10
Tree in Lower Garden.	Height	32	0
	Girth at 1 foot from the ground	3	2
	,, at 3 feet ,,	2	5
	,, at 6 ,, ,,	2	2

The tree in the Upper Garden is probably the identical one received by the late Mr. Jamieson in the latter part of 1881, or about the beginning of 1882, from the Royal Botanic Gardens, Ceylon. It will now be about sixteen years old. I made an incision in this tree on the 3rd March 1898, when it was in full flower, for the purpose of ascertaining whether it contained much milk or not. The *result satisfied my highest expectations,* for the milk simply poured out of the incision in abundance. On the 14th April, I found many ripe seeds, which had dropped, lying on the ground beneath the tree ; and I also observed that the tree was laden with fruit containing seeds in progressive stages of development. I again tapped the tree on the 14th April, but the milk was not so abundant as on the 3rd March. Perhaps, the best time to tap this species is just before and during the flowering period, but not after the seeds commence to ripen. This statement should be accepted only tentatively, for I think the best tapping season in the *Nilgiri district will eventually* be found to last from the middle of December to the middle of March. Further experiments on a larger scale can alone

satisfactorily determine the best month or months in the year for tapping. I suggest that *Castilloa* should be planted in the same situations as I have recommended for planting *Hevea*.

There has been a great deal written about the American rubber trees not being a success in this country. It would, I think, be well to bear in mind that it is only about twenty-five years ago that the Para rubber tree was introduced, and only about twenty-two years since the Ceara and the *Castilloa* were introduced into India. It is therefore rather early yet, I think, to expect to get good results from them. Several writers have given their opinions as to when tapping should be commenced; but, in my opinion, they almost all recommend the tapping to be commenced when the trees are too young. I unhesitatingly advise that neither the Para, Ceara, or *Castilloa* rubber trees should be tapped for commercial purposes until they have obtained a girth of 4 feet at 4 feet from the ground. Even after a tree has attained the girth stated, the tapping should be done carefully so as not to injure the cambium layer and therefore the consequent further normal growth of the tree.

Having got a large number of trees of the requisite girth, the question of getting the rubber extracted and collected from them does not seem to me to present any great difficulty. It would, I think, be very easy to train a few men in the best methods of tapping each of the above-named species, and these men would quickly train others. These trained men and their assistants could then be employed to collect rubber from the trees in the Government plantations or forests by contract, and, as it were, sell the rubber to Government at so much per pound, viss, or maund. These rubber collectors would, of course, need to be controlled in their operations. I do not think it will ever pay to collect rubber by daily-paid labour; it will have to be done by some system of contract.

I venture to draw attention to what Robert Cross has written about the quantity of rubber yielded by *Hevea* in its native country. He remarks, "Although many of the trees of 'this class are large, the quantity of milk obtained is surprisingly 'little." It will therefore be well not to expect each rubber-yielding tree to produce a large quantity of rubber at each tapping. The solution of the question, perhaps, lies in having a large number of trees, and in not expecting to get more than a small to moderate yield of rubber from each tree.

Bending Tests of Wood.

The following statement showing results of tests in bending made on specimens of wood supplied by him to the Workshops of the College of Engineering in Madras, have been communicated by the District Forest Officer of South Coimbatore.

No.	Name of specimen of wood.	Dimensions. Length, inches = l × 12.	Breadth, inches = b.	Depth, inches = d.	Weight of specimen, oz.	Weight per cubic foot, lbs.	Load in tons, L.	Deflection at centre in inches under the load L	Modulus of Elasticity lbs.	Breaking load in tons.	F_T maximum stress at extreme fibre, lbs. per sq. inch.	K. modulus of rupture.	Remarks.
1	Stephegyne pazvifolia	25¾	1·69	1·67	39¾	60·56	...	...	..	·708	10599	588·8	Very deep vertical flaw—bad specimen.
2	Gluta travancorica ...	26¾	1·91	1·92	48¼	53·12	·5	·198	968755	·928	9299	516·6	Good specimen.
3	Dalbergia latifolia ...	27⅜	1·77	1·73	47	60·55	·5	·461	613770	·910	12121	673·4	Vertical crack at one end—bad specimen.
4	Terminalia tomentosa	28⅛	1·69	1·73	50½	66·33	·2	·098	1209560	1·035	14437	802·0	Crushed and torn—good specimen.
5	Cassia Fistula ...	25⅞	1·85	1·84	60¼	73·88	·5	·094	2393000	1·533	17270	959·4	Do. Very good specimen.
6	Mesua ferrea ...	27	1·57	1·61	49¼	77·93	·2	·164	965284	·753	13056	725·3	Knotty specimen.
7	Xylia dolabriformis	$28\frac{1}{16}$	1·84	1·84	57¼	65·08	·5	·183	1229500	1·198	13570	753·9	Torn only—good specimen.
8	Anogeissus latifolia	$26\frac{25}{32}$	1·79	1·78	55¼	69·90	·5	·293	866900	1·235	15600	866·6	Fine specimen—knotty, crushed and torn.
9	Bassia latifolia ...	26⅝	1·50	1·53	40¼	71·13	...	...	...	·4	8198	455·4	Fracture, fine specimen, knotty, all knots in compression.
10	Terminalia paniculata	26¾	1·70	1·74	47½	64·86	·6	·256	1359350	1·20	16451	914·0	Good fracture and specimen.

$$K = \frac{We}{bd.} = \frac{1}{18} F_T$$

The Conservation of Soil Moisture and Economy in the use of Irrigation Water

BY E. W. HILGARD AND R. H. LOUGHRIDGE.

The exceptionally dry season of 1897-8, coupled with the early cessation of rains in the spring of 1897, have brought about in California a more extended failure of cereals and pasturage, and shallow-rooted crops generally, than in any year since the State became a prominently agricultural one, the season of 1876-7 being the nearest to carry with it a similar deficiency in crop production. It has been the effort of the Experiment Station to utilize the present unusual season for the study of the *limits of endurance of drought on the part* of the several crop plants, and with it to determine the minimum of water that will suffice for their satisfactory growth in the several soils. While far from completed, this work (involving many hundreds of determinations of moisture in soils) has already yielded some results which render it desirable that they should be placed before the farmers and discussed at once, in order to provide against a recurrence of avoidable injury in the future.

Amount of Water required by crops.—It is not very generally understood how large an amount of water is required for the production even of fair crops ; for the maximum of possible product is rarely obtained on the large scale, because it is not often that *all* conditions are at their best at any one time and locality. But from numerous observations, made both in Europe and in the Eastern United States, it has been found that from 300 to over 500 tons of water are on the average required to

produce one ton of dry vegetable matter. In Wisconsin, King found that a two-ton crop of oat hay required over one thousand tons of water per acre, equal to about nine inches of rainfall. The average rate for field crops at large is given by European observers at 325 times the weight of dry matter produced, being at the rate of about three inches of rainfall actually evaporated through the plant.

These data should enable us to estimate the adequacy of the moisture contained in the soil at the beginning of the dry season to mature the crop, provided we make due allowance for any growth already made at the time, and provided also that the estimates as to the water-requirements derived from the experience of the countries of summer rains (the humid regions) hold good for the arid region also. Whether or not this can be assumed, is among the points our experiments are designed to determine. The surprisingly successful growth and bearing especially of deciduous trees, without irrigation, despite a drought of five or six *months* in the "Franciscan climate." * has led to an impression that a less amount of water may suffice under arid conditions. For in the East, as many *weeks* of drought and intense heat would frequently suffice to destroy the crop.

Probable cause of this endurance of drought.—Doubtless the main cause of this remarkable endurance is to be found in the *much deeper rooting of all plants in arid climates*; whereby not only a much larger bulk of moist soil is at their command, but the roots are withdrawn from the injurious effects of the hot, dry surface and air.

This deeper range of the roots is not the result of foresight on the part of the plant. It could not occur on Eastern soils, because of the intervention, in the great majority of cases, of difficultly penetrable subsoils; from which, moreover, plants could draw but little nourishment on account of their "rawness." In the arid region, as a rule, subsoils in the Eastern sense do not exist; the soil mass is practically the same for several feet and in the prevalent soils is very readily penetrable to great depths. This, summarily speaking is due to the slight formation of clay, and the rarity of heavy rains, in the arid region. And this easy penetrability of the soil implies, moreover, that being well aerated, the depths of the soil are not "raw," as in the East; and therefore that the "subsoil," such as it is, may fearlessly be turned up as deeply as the farmer is willing to go with the plow, without danger of injuring the next season's crop, in all lands that are well drained; as, by reason of their depth and perviousness, is the case with most California soils.

* This name has been felicitously applied by Powell to the climate of middle and southern California which is characterized by the concentration of rains within a winter which is mild enough to constitute a growing season, while the summer is practically rainless.

It may easily be shown that while a shallow root system will stand in absolute need of frequent rains or irrigation to sustain its vitality, a deep one may brave prolonged drought with impunity, being independent of surface conditions, and able to perform all its functions out of reach of stress from lack of moisture.* It is equally clear that it is to the farmer's interest to favor, to the utmost, this deep penetration of the roots, both in the preparation and tillage of the ground, and in the use of irrigation water. For if the latter is used too frequently or too abundantly, the salutary habit of deep rooting will be abandoned by the plant, and it will, as in the East, be dependent upon frequent rain or irrigation; and also, owing to the small bulk of soil upon which it can draw for its nourishment, upon frequent and abundant fertilization.

Eastern immigrants as well as a large proportion of California farmers do not realize the privilege they possess of having a *triple and quadruple acreage of arable soil under their* feet, over and above the area for which their deeds call ; and they tenaciously continue to adhere to precautions and practices which however salutary and necessary in the region of summer rains, do not apply to this climate. The shallow plowing so persistently practised, results in the formation of a " plowsole " that plays the part of the Eastern subsoil in preventing root penetration ; limiting their range for moisture and plant food, and thus naturally causing crops to succumb to a slight stress of season which ought to have passed without injury, had the natural conditions been taken into proper consideration.

Roots follow moisture.—Very striking examples of deep rooting as the result of vertical moisture penetration can be observed in some of our native trees, which, while naturally at home on moist ground, are nevertheless sometimes found forming luxuriant clumps on the slopes and even summits of our coast ranges and foothills. If we examine the ground where this occurs in the case of California laurel we will generally find that the soil in which they grow is underlaid by slate or shale standing on edge, into the crevices of which the roots penetrate wedging them open, while themselves flattering out, and thus penetrating to moisture at considerable depth. The same may be observed in the case of the erect "bedrock" or foothill slates of the Sierra, on which native as well as fruit trees flourish in very shallow soils, sometimes reaching permanent moisture at the depth of ten or more feet below the surface. It can readily be observed during rains that there is comparatively little run off from the surface of these lands underlaid by vertical shales.

On the same principle, the grape vines which bear some of the choicest raisins of Malaga on the arid coastward slopes, are made to supply themselves with moisture, *without irrigation*, by

*** The moisture determination under a measured fruit tree gave, to the depth of eight feet, an aggregate amount of water of 1,058 tons per acre.**

opening around them large, funnel-shaped pits, which remain open in winter so as to catch the rain, causing it to penetrate downward along the tap-root of the vine, in clay shale quite similar to that of the California Coast Ranges, and like this latter, almost vertically on edge. Yet on these same slopes scarcely any natural vegetation now finds a foothold.

Similarly the "ryots" of parts of India water their crops by applying to each plant immediately around the stem such scanty measure of the precious fluid as they have taken from wells, often of considerable depth, which form their only source of water-supply. Perhaps in imitation of these, an industrious farmer has practised a similar system on the high benches of Kern River, and has successfully grown excellent fruit for years, on land that originally would grow nothing but cactus. Sub-irrigation from pipes has been applied in a similar manner.

The principle flowing from the above is simply that the most economical mode of using irrigation water is to put it "where it will do the most good," close to the stem of the plant or trunk of the tree and let it soak downward so as to form a moist path for the roots to follow to the greatest possible depth. It is this deep *penetration to natural moisture*, as a matter of fact, which enables the small quantities supplied to produce such marked effects.

Basin irrigation.—It will be noticed that this principle is practically the same as that of the irrigation of orchards, which was originally largely practised in California, but has now been mostly abandoned for furrow irrigation. The latter has been almost universally adopted, partly because it requires a great deal less hand-labor, partly under the impression that the whole of the soil of the orchard is thus most thoroughly utilized; partly also because of the injurious effect upon trees produced at times by basin irrigation.

The explanation of such injurious effects is, essentially, that cold irrigation water depresses too much the temperature of the earth immediately around the roots, and thus hinders active vegetation to an injurious extent, sometimes so as to bring about the dropping of the fruit. This, of course, is a very serious objection, to obviate which it might be necessary to reservoir the water so as to allow it to warm before being applied to the trees. In furrow irrigation the amount of soil soaked with the water is so great that the latter is soon effectually warmed up, besides not coming in contact too intimately with main roots of the tree; along which the water soaks very readily when applied to the trunk, thus affecting their temperature much more directly. It is for the fruit-grower to determine which consideration should prevail in a given case. If the water-supply be scant and warm, the most effectual use that can be made of it is to apply it immediately around the trunk of the tree, in a circular trench dug for

the purpose. When, on the contrary, irrigation water is abundant and its temperature low, it will be preferable to practice furrow irrigation, or possibly even flooding. As to the more complete use of the soil under the latter two methods, it must be remembered that while this is the case in a *horizontal* direction, yet unless irrigation is practised sparingly under the furrow system, it may easily happen that the gain made horizontally is more than offset by a corresponding loss in the *vertical* penetration of the root-system. This is amply apparent in some of the irrigated orange groves of Southern California, where the fine roots of the trees fill the surface soil as do the roots of maize in a corn field of the Mississippi States; so that the plow can hardly be run without turning them up and under. In these same orchards it will be observed, in digging down, that at a depth of a few feet the soil is too water-soaked to permit of the proper exercise of the root functions, and that the roots existing there are either inactive or diseased. That in such cases abundant irrigation and abundant fertilization alone can maintain an orchard in bearing condition, is a matter of course; and there can be no question that a great deal of the constant cry for the fertilization of orchards in the irrigated sections is due quite as much to the shallowness of rooting induced by over-irrigation, as to any really necessary exhaustion of the land. When the roots are induced to come to and remain at the surface, within a surface layer of eighteen to twenty inches it naturally becomes necessary to feed these roots abundantly, both with moisture and with plant food. This has as naturally led to an over-estimate of the requirements of the trees in both respects. Had deep rooting been encouraged at first, instead of over-stimulating the growth by surface fertilization and frequent irrigation, some delay in bearing would have been amply compensated for by less of current outlay for fertilizers, and less liability to injury from frequently unavoidable delay, or from inadequacy of irrigation.

CONSERVATION OF SOIL MOISTURE.—Alongside of economy in the use of irrigation water, the conservation of the moisture imparted to the soil either by rains or irrigation is most important; critically so where irrigation is unavailable.

Utilization of winter rains, and winter irrigation.—However strong is the popular demand for storage of the winter rainfall and flood waters, too many do not appreciate the importance of the storage they can command without the use of reservoirs, within their own soil mass. While there is a well-grounded objection to subjecting plowed land to the leaching action of the abundant rains in the humid region, no such objection holds in the case of lands lying within the limits of 20 to 25 inches of annual rainfall. Here the absorption of the winter rains should be favored to the utmost, for the run-off is mostly a dead loss. Fall plowing wherever the land is not naturally adequately absorbent, and is not thereby rendered liable to washing away, is

a very effectual mode of utilizing the winter's moisture to the utmost, so as to bring about the junction of the season's moisture with that of the previous season, which is generally considered as being a condition precedent for crop production in dry years. The same of course holds true of winter irrigation; the frequent omission of which in presence of a plentiful water supply at that season is a prolific cause of avoidable crop failures. Moistening the ground to a considerable depth by winter irrigation is a very effective mode of promoting deep rooting, and will thus stand in lieu of later irrigations, which, being more scant, tend to keep the roots near the surface.

Knowledge of the subsoil.—It cannot be too strongly insisted upon that in our arid climate, farmers should make themselves most thoroughly acquainted with their subsoil down the depth of at least four, but preferably six or eight feet. This knowledge, important enough in the East, is doubly so here, since all root functions are and must be carried on at much greater depths. It is hardly excusable that a business man calling himself a farmer should omit the most elementary precaution of examining his subsoil before planting orchard or vineyard, and should at the end of five years find his trees a dead loss in consequence of an unsuitable subsoil. Similarly, no irrigator should be ignorant of the time or amount of water it takes to wet his soil to a certain depth. We have lately seen a whole community suffering from the visible decline of the thrift of its fruit trees, which occurred despite of what was considered abundant irrigation; *i.e.*, allowing the water to run for a given length of time, deemed to be sufficient. Yet on being called in to investigate the causes of the trouble, the station staff found that the irrigation water had failed to penetrate during the allotted time to any beneficial extent, so that the trees were, in the main, suffering from lack of moisture—a fact that could have been verified by any one of the owners concerned, by simply boring or digging a hole or two. But no one had thought of doing so, and all kinds of mysterious causes were conjectured to be at work in the suffering orchards. A definite knowledge of the rapidity with which irrigation water penetrates downwards and sideways in his soil should form a part of the mental equipment of every irrigator, particularly in arranging his head ditches. For in sandy lands it may easily happen that when these are too far apart, the water near the head ditch is already wasting into the country drainage at the depth of ten or twelve feet, before any has reached the end of the furrows, or has wetted the lower half adequately. Many such cases come under our observation, and such ignorance of the conditions governing one of the most important factors of success is hardly excusable in any one. Nor is the quality of the water used indifferent in this connection; for waters containing alkali will fail to penetrate the soil as quickly as would ordinary stream waters.

Preventing evaporation.—But supposing the moisture to have reached the depths of the soil, whether from rains or from irrigation, it is essential that proper means be employed for retaining it in the land, and especially to prevent evaporation. That this is best accomplished by a mulch on the surface, and that the best mulch for the purpose, which need not be hauled on or off and is always ready, is a surface layer of loose, well-tilled soil, is now pretty well understood by all. But the extent to which the presence or absence of such a non-evaporating layer influences plant growth and fruit production in a critical time, is not so fully appreciated. Our plates * give an illustrative example of trees and fruit grown this season on adjacent fields, with only a lane between, the soil and all natural conditions being absolutely identical; the only difference being the presence and absence of cultivation. In the present case the cultivation was omitted on principle by owner, who considered cultivation superfluous on the loose, generous soil of Alameda creek; while his neighbor, across the way, held the opposite belief, and had this season cultivated to an extra depth to conserve moisture. The cultural results show a remarkable difference and need no comment, although it may be of interest to mention that the year's growth on the one hand was over three feet, on the other barely three inches. The determination of the moisture held by the soil in July to the depth of six feet gave the following results:

Depth in Soil.	Cultivated.		Uncultivated.	
	Per Cent.	Tons per Acre.	Per Cent.	Tons per Acre.
First Foot ...	6·4	128	4·3	86
Second Foot ...	5·8	116	4·4	88
Third Foot ...	6·4	128	3·9	78
Fourth Foot ...	6·5	130	5·1	102
Fifth Foot ...	6·7	134	3·4	68
Sixth Foot ...	6·0	120	4·5	90
Total for six feet ...	6·3	756	4·2	512

The difference of 244 tons per acre of ground shown by the analyses is quite sufficient, according to the data given at

* We regret that we have been unable to reproduce the plates.
Hon. Ed.

the beginning of this bulletin, to account for the observed difference in the cultural result. The cause of this difference was that in the *uncultivated* field there was a compacted surface layer several inches in thickness, which forcibly abstracted the moisture from the substrata and evaporated it from its surface; while the loose surface soil on the *cultivated* ground was unable to take any moisture from the denser subsoil. This is well illustrated by the familiar fact that while a dry brick will suck a wet sponge dry, a dry sponge (corresponding to the loose surface soil) is unable to take any water from a wet brick. Besides, the tilled surface soil forms a non-conducting layer protecting the subsoil from the sun's heat and the dryness of the air.

In the East, where this principle is well understood, it is considered that a surface layer three inches in thickness is sufficient to afford effective protection. But what is adequate in the region of summer rains is quite insufficient in California and in the arid region generally. It takes fully twice the thickness mentioned, and preferably more, to afford protection against the drought and heat lasting five or six months at a stretch. Here again we find an important point in which our practice must differ from that of the East and of the Old World.

The beneficial effects of summer fallow in California are assuredly due quite as much to the conservation of moisture brought about by the tilled surface layer, as by the weathering of the soil to which the efficacy of the fallow is commonly ascribed. Witness the fact that weeds come up freely on summer-fallow as late as August, when unplowed land is as bare as a barn floor.

Similarly on our mostly new and unexhausted lands, the bad effects of weed growth are doubtless due fully as much to the waste of moisture going on through their leaves as to the competition with the crop in plant food. Hence all good orchardists are very careful about keeping their ground clean in summer; but it must not be forgotten that by doing so they quickly deplete their lands of vegetable matter, which requires systematic replacement if production is to continue normally. Yet of the two evils, the loss of moisture is more to be dreaded, and very generally in practice the more difficult to remedy.

Forestry vs. Tree-Planting.

By B. E. Fernow,

Director, N. Y. State College of Forestry.

The treelessness of the prairie and plains country naturally suggested the planting of trees to a people who had learned, in more favoured sections, the comfort, the beauty and the value of an arborescent growth. The wind-break effect of a

shelter belt, the shade of a grove, were soon appreciated, by the early settler, and finally, the hope of securing at least firewood supplies, if not working timber, induced him to resort-to the unfamiliar occupation of planting groves.

One would think that the incentive to secure these well-known comforts would have been sufficient to stimulate every newcomer to do his share in improving the landscape and the local climate around his house, barn and fields by tree-planting, but so sluggish is human nature that some additional stimulus seemed necessary. The Federal Government, with a most liberal hand, gave away thousands of acres of land to induce settlers to improve their homes by timber-planting, and private effort added the stimulus of the emotions, on which Arbor Day is founded.

Yet even so, with a quarter century or more of effort there is still need, it seems, of making tree-planting attractive in the plains. I do not propose to discuss the reasons, they are mainly, expense, frequent failure on account of unfavourable climate, and ignorance as to proper procedure, and finally the discouragement which comes from a non-fulfilment of mistaken expectations, which the claims of the stimulators had aroused.

The tree-planting movement of the Western prairie and plains States, however good it has been for those States in stimulating arboriculture, has done much harm to the forestry movement in the Eastern States, where some good but unenlightened enthusiasts confounded the objects, aims and methods of arboriculture in the plains with the objects, aims and methods of forestry in the forested States. The problems in these States are entirely different and the methods of forestry are entirely different from the methods of arboriculture as practised in the treeless plains.

Here all planting is done for comfort rather than for material results. The man who expects to do much more than raise firewood, such as the Eastern States will have always more than enough, even under the worst mismanagement, has not studied the relation of tree-growth to climate. Even if he should succeed in growing small dimension material for certain purposes, he may never expect to enter the great lumber market, whose demands are for sawlogs to the amount of a half billion dollars or so a year. If there were no other reasons the expense would forbid.

Forests—*lumber forests*—grow and will always grow, in humid regions, and forestry—the rational management of forests for wood supplies—will be practised in those regions and on those soils which nature has best fitted to produce wood crops, namely, the poor soils in the humid regions, leaving the good soils to agriculture.

But forestry is not tree-planting, although occasionally the forester is forced to use the planting tool. The axe is the forester's tool, just as it is the tool of the lumberman. It is by cutting trees that the forest is not only being utilized but preserved, provided the cutting is done properly according to the principles which forestry teaches. Just as mankind preserves itself by the constant renewal in the young, so the forest is preserved by the removal of the old trees grown to useful size and the attendant renewal of the young crop.

Where, to be sure, the lumberman's injudicious use of the axe and the fire following his operations, have given over the soil to the weeds in tree form, cutting alone may not always remedy the conditions; nevertheless tree-planting, expensive and hazardous, is the *ultima ratio* of the forester.

The tree-planters of the plains have, for a long time, clouded the issues of the forestry movement in the East and West by their gospel of arboriculture and Arbor Days; they have antagonized the lumbermen, the owners of our woodlands, without whose work they could not have settled the treeless plains and built their houses and barns, and thus they have retarded, unwillingly, to be sure, the development of forestry.

The times are changing; owners of woodlands begin to see that forestry is not tree-planting but tree-cutting, and that when the axe is laid on the forest tree, forestry must begin, not when the tree is cut.

Not only are now several firms of lumbermen employing foresters to direct their cutting of trees, but the State of New York has established a school, where the art of forestry may be studied in all its branches.

Here rational tree-cutting, as well as rational tree-planting, reforestation of denuded hill as well as grove planting in the prairie and plain, and the difference between the two, will be taught.—(*The Forester.*)

The "Shinia" Leaves of Cyprus.

A despatch has been recently received from the Chief Secretary of Cyprus enclosing translations of pamphlets by M. P. Gennadius, Director of Agriculture in that island, on the industry connected with the cultivation of the shinia and laurel shrubs. *Pistacia lentiscus* is a shrub that grows abundantly in most parts of Cyprus, and is called in the island "shinia;" a variety of this shinia is the mastic shrub of Scio, the leaves only of which have a commercial value, serving as a tanning and painting material. From the wood of the shrub, charcoal of good quality is made, and from its seed, which is eaten by

goats and pigs, oil can be extracted, which is fit, not only for burning purposes, but, in case of necessity, for food as well. For some time, shinia leaves were exported from Cyprus to England in small quantities by the Cyprus Company, but the principal market for shinia leaves is Palermo, in Sicily, to which port there is an annual exportation from Tunis of 10 000 tons; they are there used chiefly for the adulteration of sumach (*Rhus coriaria*), which is grown in large quantities in Sicily, and is thence exported to England and France. A good quality of shinia leaves is also consumed at Lyons as a dyeing material for silk stuffs.

The crop is gathered during the months of April to September, the leafy branches of the shrub being cut off, laid in heaps on the ground, and left there until dry. This takes place generally in four or five days, during which the heaps are left undisturbed, in order that as few leaves as possible should come in direct contact with the sun, which bleaches and overdries them, and thus depreciates their value. After being dried, the branches are beaten with a flail to detach the leaves, which are then packed in sacks for the market. Before the beating takes place the top branches which cover each heap are removed and thrown away, because the leaves of these, having been bleached and burned up by the sun, are not only useless, but also injurious, when mixed with the rest of the produce. Shinia leaves should not be gathered after rain, as an inferior quality is then obtained.

Another shrub, the laurel of Apollo, *Laurus nobilis*, is a most useful plant, its wood, leaves, and fruit being all available for various purposes. The wood, although not very strong, serves, nevertheless, for structural purposes and cabinet-making, it is also used for fuel. The fruit resembles small olives, and when pressed, yields a greenish oil as thick as butter, and exhaling a strong, pleasant odour. This oil, well known to commerce as "laurel oil," is used in pharmacy and in perfumery, and is a protective against insects. The leaves serve as seasoning for cooked or preserved meats and fish, for which purpose they are dried and sold, or are exported to other countries where the tree itself will not flourish. A considerable exportation of laurel leaves from Greece and the East is annually made to Austria (through Trieste) and the United States of America (through New York. The leaves are also used for packing with choice kinds of raisins and figs, in order to impart to those fruits the fragrance of the laurel oil, as well as to protect them against injurious insects. In veterinary surgery laurel leaves are considered to be an excellent external remedy against various cattle parasites, a decoction thereof being used for washing the parts of the animals most attacked by flies and other parasites. The laurel shrub is propagated only through

its seeds, which are sown as fresh as possible direct in the soil, and not in pots or boxes, as is the case with the seeds of some other plants. It prospers in a rather temperate soil, such as that of the southern range of the mountains of Cyprus, and, where soil and climate are suitable, will begin to bear fruit four or five years after the seed has been sown.—(*Imperial Institute Journal.*)

A Useful Diary.

We have to thank the "Indian and Eastern Engineer for a very useful diary for 1899 just received and which they ask us to notice. The have much pleasure in saying that the Tables of Indian weights and measures and other information given, add greatly to the value of the book.